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SMITHSONIAN INSTITUTION

UNITED STATES NATIONAL MUSEUM Bulletin 115

THE FOSSIL CRINOID GENUS DOLATO-CRINUS AND ITS ALLIES

RV

FRANK SPRINGER

Associate in Paleontology, United States National Museum.



WASHINGTON
GOVERNMENT PRINTING OFFICE
1921

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BY

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The present work forms No. 115 of the Bulletin series.

WILLIAM DEC. RAVENEL,

Administrative Assistant to the Secretary,

In charge of the United States National Museum.

WASHINGTON, D. C., January 31, 1921.

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PREFACE.

This paper is the result of studies begun many years ago, with a view to clarifying the record of the crinoid forms herein discussed from the confusion growing out of the excessive activity of some authors in species making. The drawings of the Miller and Gurley types, and those for plates 1 to 4 on Comanthocrinus, Hadrocrinus, and Himerocrinus, were made by Mr. Kenneth M. Chapman of Santa Fe, New Mexico. The text-figures were prepared by my assistant, Dr. Herrick E. Wilson. In the preparation of the other figures upon Dolatocrinus I have had the assistance of Dr. R. S. Bassler in photographing the specimens, and of Miss Francesca Wieser, of the United States Geological Survey staff, in retouching the prints, for which I extend to them my sincere thanks.

WASHINGTON, D. C., April 1, 1920.

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THE FOSSIL CRINOID GENUS DOLATOCRINUS AND ITS ALLIES.

By Frank Springer.

Associate in Paleontology, United States National Museum.

CRINOID FAUNAS OF THE MIDDLE DEVONIAN.

The crinoids which form the subject of this Bulletin constitute a small group of generic forms having a singularly restricted distribution, being confined, so far as known (after a feeble beginning with two hitherto undescribed species in the Niagaran and Helderbergian),¹ to the Middle Devonian of North America. They belong typically to the Gulf fauna, which during Onondaga time brought widespread coral reefs into the interior region—best developed in the Louisville, Kentucky, area. The faunas introduced by this Gulf invasion continued through the later Onondaga and Hamilton epochs, persisting in the Louisville area, extending far to the north into Canada, and migrating around the Cincinnati axis into the western part of New York.

This is the interpretation of the faunal conditions of that time given by Prof. Charles Schuchert, in his Paleogeography of North America,² based upon general paleontological evidence; and the occurrence of the crinoid forms under consideration is in perfect agreement with it. The principal colony was in the Louisville area, where these forms appear in rocks of Onondaga age, culminating and becoming extinct in the succeeding Hamilton. They spread northward and northeasterly, into Michigan, western New York, and adjacent Canadian localities. No representative of these genera is known outside of the limits thus indicated.

The leading type in abundance, so far as our collections show, was Dolatocrinus, which from a few well-marked species in the Onondaga increased to great profusion in number and variety, reaching its acme in the Hamilton, where it is represented by numerous species. But whereas in the Onondaga the species were extremely well defined, rapid development ensued in the Hamilton under conditions favorable to a rampant growth, in which certain characters, stable and thoroughly reliable in the earlier formation, become worthless for

¹ Springer. On the crinoid genus Scyphocrinus, 1917, p. 25.

² Bull. Geol. Soc. Amer., vol. 20 (1910), pp. 540, 544-545.

the discrimination of species. This was followed by complete extinction, no vestige of this or allied types having ever been found in later formations.

The forms in question are all included in the suborder Camerata, but for lack of material the treatment of them in the monograph of that group by Wachsmuth and myself in 1897 was inadequate. A considerable number of new species has been since described by other authors, and I have in the meantime accumulated much additional material. This in conjunction with the types of the later described species—chiefly in the Walker Museum of the University of Chicago, generously placed at my disposal by Doctor Weller—will afford the information necessary for a more satisfactory discussion and illustration of these genera. Many drawings for this purpose were prepared some years ago, but the further preparation and publication of the memoir have been delayed by the pressure of other work.

The occasion for the present paper is the desirability of making available for the use of others some of the matter which I have long had in manuscript bearing upon the generic relations of the several forms comprising this group, including the recognition of two new genera.

The group belongs to the Camerate family Melocrinidae, which was for convenience divided by Wachsmuth and Springer into two sections, Melocrinites and Dolatocrinites, based upon characters not sufficiently constant for family distinction. By transferring the genus Patelliocrinus to the first of these sections and placing it next. to Macrostylocrinus with three basals, we shall have the two sections somewhat better defined with reference to the general habitus and form of calvx than they have been when depending upon the very slight and indecisive difference in the plates of the anal interradius above the first range. The genera of the first section all have a more or less elongate calyx, the dorsal cup being usually higher than wide, subturbinate in form, expanding from a relatively narrow base to the zone of greatest width at the level of the arms. In the second section these characters are more or less reversed, the cup being usually subovoid or hemispheric, broadly rounded, and wider than high. Technocrinus may be regarded as an intermediate form, the earlier species, now herein described, being of the latter type.

The new genera are proposed for forms, one of which was described by Miller and Gurley as Stereocrinus indianensis, and the other by Lyon as Hadrocrinus plenissimus, and both of which are

^{*} North American Crinoidea Camerata, Memoirs Museum Comparative Zoology, Harvard, vol. 21, pp. 304-329.

[•] North American Crinoidea Camerata, pp. 264-267.

thoroughly distinct from the types with which they have been associated. The following definition and brief discussion will be sufficient for the present purpose:

Family MELOCRINIDAE; section DOLATOCRINITES.

Monocyclic. Lower brachials, with well-defined interbrachials, forming part of the dorsal cup. Radials in contact all around. Symmetry of dorsal cup but little, or not at all, disturbed by anal structures; cup usually wider than high, broadly rounded below, with base depressed, flattened, or concave. Arms usually simple; biserial with few exceptions.

ANALYSIS OF THE GENERA.

Arms simple, biserial; base obconical; no anals...... Trchnocrinus.

Basals 4:

Arms branching, biserial both above and below the bifurca-	
tions; base forming an inverted cone; no anals	CLONOCRINUS.
Basals 3, unequal, sometimes anchylosed:	
Calyx usually small, or of moderate to large size; iBr few, in not	
over two ranges.	
Anal side not differentiated in dorsal cup.	
Dorsal cup low and wide; basals small, undivided, sunk	
in a shallow cavity; arms simple, uniserial	ALLOCRINUS.
Dorsal cup higher than tegmen, broadly rounded; base	
usually flattened or concave.	
Tegmen flat or low convex, nearly symmetrical,	
with subcentral anal tube.	
Arms little known; probably biserial, and	
simple, except in one species which should	
go into another genus; openings 10 to 40.	
Basals small, usually in a conical depres-	
sion and anchylosed; the smaller one,	
when distinguishable, in left anterior	
position.	
IBr 2	DOLATOCRINUS.
. IBr 1	STEREOCRINUS.
Anal side slightly differentiated in the dorsal cup by an	
extra plate in second range.	
Dorsal cup subcylindrical; basals large, divided;	`
radials large, IBr small; arms unknown	Centriocrinus_
Anal side also strongly differentiated in the tegmen by a	
series of large, ridge-like plates extending from the second	
iBr range to base of anal tube.	
Dorsal cup low, broadly rounded, base flattened or	
concave; basals usually divided.	
Tegmen exceeding dorsal cup in height, strongly	
bulging posteriorly, but with subcentral anal	
tube.	

Basals distinct; small basal in left posterior position; IBr 2, the first reduced and

irregular in form...... Comanthocrinus, new genus.

Arms uniserial, simple.

Basals 3, unequal, sometimes anchylosed—Continued.

Calyx very large; iBr in 3 to 7 ranges.

Anal side may be slightly differentiated above the first range.

Dorsal cup broad, low, and flattened.

Tegmen low convex.

Base small, with shallow concavity involving radials and covered by column; basals almost eliminated by atrophy.

Arms biserial, simple, heavy and few in number—about 4 to the ray; iBr in 5 or more ranges.

Dorsal cup broadly rounded.

Base deeply concave, forming an inverted cone.

The material used in the following descriptions and discussions and in the illustrations, unless otherwise stated, is all in the author's collection now in the United States National Museum.

COMANTHOCRINUS, new genus.

In addition to the larger characters for this genus previously mentioned, the following observations are pertinent:

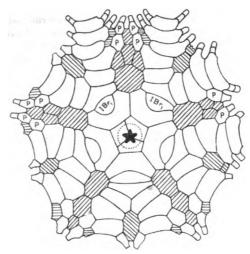


Fig. 1. -Comanthocrinus.

//// = i Br \\\ = i II Br = interpinnulars p = pinnulars

The greatly elevated tegmen, with its conspicuous bulging at the posterior side, and the accompanying marked differentiation of the anal series, produce a wide departure from the nearly pentamerous ymmetry which prevails in most of the genera of this group. The

bulging is due to the great enlargement and asymmetrical swelling of the intestine, which nevertheless discharges from the tegmen almost centrally, through a small anal tube. The interbrachials are few in number, consisting of one large plate, which may be followed by one or two in the succeeding ranges, flanked by other plates resembling interbrachials, but which are in fact fixed pinnulars; interpinnulars sometimes present. The anal side is differentiated in the tegmen by a median row of large plates, and sometimes in the dorsal cup by an extra plate in the second interbrachial range, but this is not constant; a narrow linear series passes up to the median row above mentioned.

The base, in the left posterior position of the small plate, is not only different from that of the associated genera, but is a departure from the rule in monocyclic crinoids generally, this exceptional orientation being known only in some specimens of Storthingocrinus, and the Recent genus, Hyocrinus. This character is nearly constant in both species.

The condition of the first primibrach is also exceptional and peculiar. Instead of being absent, as in Stereocrinus and Hadrocrinus, it is reduced to a small lunate or elliptic plate, occupying a curved socket cut out of the distal face of the radial (or also out of the plate above it), usually less than the width of that plate, but sometimes extending entirely across it. A similar irregularity has been observed in Eucalyptocrinus rosaceus, from the Devonian of the Eifel, in which the first primibrach is also sometimes entirely absent.

The secundibrachs are arched into strongly rounded rays, with broad depressions between. They form a continuous series which pass into 10 strong, free, uniserial arms. They are incorporated in the calyx to a varying extent by means of fixed pinnules, the bases of which are closely united by suture. The lower secundibrachs following the first bear a single pinnule, on the outside and inside of the dichotom successively, while IIBr, and probably all succeeding brachials bear pinnules on both sides, increasing in number until there are two on each side. This bipinnulate or quadripinnulate structure is also unusual, but I have other good examples of it in the genera Carpocrinus and Lampterocrinus. Ambulacral covering plates in double series extend to near the base of the anal tube, and pinnular ambulacra are also present, as in Marsipocrinus. These pinnules give rise to openings through the calyx wall between the bases of the rays, such as have been noted in species of Dolatocrinus, Batocrinus, and other genera, in which they were formerly interpreted as "respiratory pores." I have already explained their nature and origin in the memoir on the genus Scyphocrinus, 1917, (pp. 40-46).

In the great preponderance of the ventral portion of the calyx, as evidenced by the flattened dorsal cup and high tegmen, this genus

resembles the condition of the adult comatulids generally, in which the base is only a platform for the support of the visceral mass, in contrast to the typical plan of the crinoids, in which the dorsal parts form a cup inclosing the viscera. Among the paleozoic crinoids of other Camerate families some exceptionally took the same form, as, for example, the genera Agaricocrinus, Amphoracrinus, Cyphocrinus, and the discoid species of Platycrinus.

The genus is represented by at least two species, one from the Onondaga and one from the Hamilton. The Hamilton form was described by Miller and Gurley as Stereocrinus indianensis, with little indication of its peculiar characters, although they noted that the species bears little or no resemblance to the type, and referred it to Stereocrinus only because of its supposed identity under the generic formula of "two primary radials"—that is, only one primibrach. Even this was incorrect observation, the authors failing to see the reduced first primibrach, which is constant in all specimens in which the plates can be distinguished. Their type was from the Louisville area, where a number of specimens preserving the tegmen have been found. Specimens of what may be the same species occur in the Hamilton of western New York, in one of which the character of the uniserial arms is well shown.

The Onondaga species is much larger. Specimens from the Falls of the Ohio at Louisville show some structural details better than the Hamilton form, especially the extreme of fixed pinnulation; but the tegmen is not preserved. Therefore I take the S. indianensis as the type of the genus, and for the Onondaga form I propose the name Comanthocrinus priscus. The latter species also occurs in western New York.

Genotype.—Stereocrinus indianensis Miller and Gurley.

Distribution.—Middle Devonian: Louisville area and New York.

COMANTHOCRINUS INDIANENSIS (Miller and Gurley).

Plate 1, figs. 1-6.

• Stereocrinus indianensis MILLER and GURLEY, Bulletin No. 12, Illinois State Museum, 1897, p. 38, pl. 3, figs. 13-15.—Rowley in Greene, Contr. Ind. Pal., 1904, vol. 1, p. 182, pl. 54, figs. 7, 8.

Type of the genus. The species is of relatively small size, average specimens being about 20 mm. wide on the base and 17 mm. high to the top of the tegmen. Dorsal cup low and flat; the relations of its component plates are best shown by the accompanying generic diagram (text fig. 1), composed upon the evidence of 12 specimens of this species; the reduced and modified first primibrach is drawn in its various forms in the different rays, also variations in the inter-

^{*} Bull. No. 12, Ill. St. Mus., 1897, p. 38, pl. 3, figs. 13-15.

brachials. The species represents a retrogression from the older form in the less extent of incorporation of brachials in the calyx, or a progression in the direction of greater freedom of the arms, whichever way one pleases to consider the case. The chief resulting difference to be noted is in the number and depth of incorporation of the fixed pinnules. Here the arm becomes free at about the third or fourth IIBr. IIBr, has an incorporated pinnule on the outer side of the dichotom, the base of which may also connect by suture with IIBr, and . IIBr, has a free pinnule at the inside of the dichotom, and IIBr, bears two free pinnules, one from each side. Beyond this in the free arm the pinnules increase to three and four to the brachial. In a specimen with arms the pinnulation can be traced on the outside of the dichotom to the twenty-second free brachial, and on the inside to the seventeenth. All have at least one pinnule at each side, and about 12 brachials have two pinnules at one or both sides. On bipinnulate brachials the outer pinnule is usually at a different level from the inner. The pinnules are extremely slender, and in the one specimen in which they are partially preserved divide into still smaller branches. The openings for the fixed pinnules are small, round, and project slightly from the edge. The course of the tegmen ambulacra leading to them may be traced by the elongate slits, from which the minute covering pieces have fallen away. (Compare figs. 4 and 10 on pl. 1.)

Interbrachials in the second range usually two (or only one) in number, with an additional plate between the two at the anal side, usually followed by a single plate in the third range. The anal side is well distinguished in the tegmen by a row of large plates (the largest in the tegmen) having a well-defined median ridge extending from just above the brachial zone to the base of the anal tube; the swollen area which marks the position of the gut does not coincide with this ridge, but lies asymmetrically to the left of it. The tegmen is highly elevated, strongly bulging at the left posterior; the anal series and some of the axillary ambulacrals sharply pustulose. Interbrachial plates of dorsal cup may have obscure ornamentation, usually obliterated.

Horizon and locality.—Hamilton formation: Clark County, Indiana; Louisville, Kentucky; and Ontario County, New York.

COMANTHOCRINUS PRISCUS, new species.

Plate 1, figs. 7-10.

A species double the size of the type—an average of 8 specimens being about 40 mm. width of calyx at the arm bases. As the tegmen has not been found, the comparative height can not be given. Dorsal cup broad, shallow, and strongly concave. The disparity in size evidenced by the wider spread of calyx in this species is correlated

with a much greater extent of incorporation of brachials by means of the fixed pinnules. The broadly rounded secundibrachs are strongly arched exteriorly, and are deeply V-shaped on the ventral side, the wings of the V being further prolonged by the pinnules, the lower ossicles of which form a continuous wall in the depressed interbrachial areas. These give the appearance of numerous iBr plates above the very large first interbrachial; but in fact the interbrachials are limited to a single narrow plate following the first, or two in linear series, the second of which may not reach to the exterior, while the other rather numerous plates in the area are all pinnulars. In this way secundibrachs to the height of the seventh are incorporated. IIBr₂ has a pinnule to the outside of the dichotom, and IIBr₃ has one to the inside, neither of them showing externally (except at the margin),



FIG. 2.—PINNULES OF COMANTHO-CRINUS,

with 3 or more pinnule-ossicles incorporated. IIBr₄ to IIBr₅ have from 2 to 4 pinnules to each brachial, with 2 or more pinnulars incorporated. The reduced first primibrach occupies an oval space between the radial and the axillary IBr, both of which are more or less excavated for its reception. It is usually small, strongly protuberant, and the radial ridge following the rays begins with this plate. The anal side is scarcely differentiated,

two narrow plates tandem succeeding the large first plate and passing toward the tegmen, which is not preserved in any of our-specimens.

The inside of the dorsal cup is marked by an extraordinary complex of grooves and ridges from the basals and radials up, which are doubtless for the lodgement of nerve cords, but the exact function of so many is not clear. They are comparable in number and position with the ridges and furrows seen upon the dorsal side of calyx plates in well-preserved specimens of *Himerocrinus plenissimus*, but nothing so intricate has been observed upon the inner surface in other forms. A few sharp nodes appear at the exterior on radials and interbrachials.

Most of the material is in poor condition, but we are fortunate in having two specimens which, except for the lack of the tegmen, are remarkably well preserved for exhibiting the essential characters of the species; in one the dorsal and ventral surfaces are completely exposed, and in the other the ventral side only. By means of these we are able to illustrate both aspects of the calyx, and to show the actual relations of the incorporated plates by diagrammatic sketch, as well as by direct drawings. Several other fragmentary specimens. confirm the description in various particulars.

With the incorporation of the lower pinnules in the calyx wall by the growth of interradial structures, the space available for their accommodation became reduced, resulting in more or less displacement by crowding, packing and overlapping, so that the pinnulars can not always be traced in linear succession, especially at the dorsal side. Some pinnulars well developed at the interior of the calyx wall are smaller exteriorly, or are not seen at all, thus giving rise to confusion when comparing the different views in the figures. Thus the first pinnule, as seen from the ventral side, is plainly given off from IIBr, whereas at the dorsal side the lowest fixed pinnular appears to be connected usually with IIB, sometimes with IIBr, and the pinnulars connecting with IIBr, and IIBr, are usually not visible at the exterior. I have shown the mode of succession by the diagram (text-fig. 2), made from the ventral side, and the above fact must be remembered when studying it, as well as when comparing the dorsal and ventral views of the calvx in the same specimen shown by plate 1, figures 7, 8. The enlargement of the lower pinnulars ventrally is at the expense of the adjacent plates, and therefore the outer surface of the large interbrachial, contrary to the usual rule in the crinoids, is larger than the inner.

Professor Rowley, in Greene's Contribution to Indiana Paleontology has described under the name Stereocrinus idilatus a fragmentary specimen from the "Upper Helderberg" at the Falls of the Ohio, which may possibly be identical with this species; but it is impossible from the figure or description to make out any specific characters. Rowley noted, however, a marked difference between this form and Stereocrinus, and said that if he had better material he would not hesitate to erect a new genus for its reception.

Horizon and locality.—Onondaga limestone: Louisville, Kentucky, and Genesee County, New York.

Genus HADROCRINUS Lyon.

Plate 2, fig. 1.

Hadrocrinus Lyon, Transactions American Philosophical Society, vol. 13, 1869, p. 445-451, pl. 26, fig. a (not b and c).—Wachsmuth and Springer, 1897, North American Crinoidea Camerata, pp. 327-8, pl. 24, fig. 1.

Lyon's definition and formula for the genus specified 2 by 5 plates in the first radial series, which in our terms would mean that it has only one primibrach; and he expressly stated in a note to the generic definition on page 445 that "the formula is intended to receive all crinoids with only two ray-pieces in the primary series." Although his first species in order of description was *H. plenissimus*, the only species which agrees with his generic definition in the above character

⁴ Vol. 2, 1906, p. 8, pl. 3, fig. 5.

is *H. discus*. In the absence of any designation by the author, this should be taken as the type species for that reason. Furthermore Wachsmuth and Springer specifically declared *discus* to be the type, and it therefore is the genotype by subsequent designation. *H. plenissimus* becomes the type of a new genus. A third species,

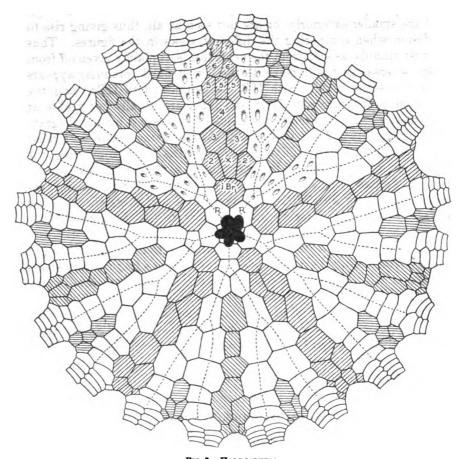


FIG. 3.—HADROCRINUS.

////= i Br; \\ = i III Br; = i III Br; dotted line = R R and Br.

named by Lyon *H. pentagonus* in the text and *H. angularis* on the plate (fig. c), is founded on a fragmentary detached base, probably belonging to *Dolatocrinus grandis*.

The type species is extremely rare, only three specimens besides Lyon's original having been found. Although all imperfect, they exhibit the generic characters very satisfactorily, showing a wide-spreading calyx, with a low tegmen of rather large smooth plates. The bases of the very heavy biserial arms, restricted in number to

⁷ N. A. Crin. Cam., 1897, p. 327

20, and therefore with only three orders of brachials, are well shown. The most remarkable thing about this form, however, is the condition of the base. With the radials included, there is a shallow basal cavity in which the basals are actually wanting in the specimens, but in one traces of the attachment of four small remnants of plates are seen inside the ring of radials (text fig. 4). Although their presence is indicated by crenulae in the small notches at the junction of the radials, the basals were practically eliminated from the calyx.

They are entirely absent in the three specimens showing these parts, the proximal edge of the radials being deeply incised by the lobes of the axial canal. A huge column facet enveloped the entire base, including the radials and part of the next range; and the basals, thus shut out from the exterior, tended to disappear by atrophy. Such an almost complete elimination of basals has not been observed in any other Camerate crinoid, but is paralleled among the Flexibilia by the Silurian genus Cleistocrinus Springer, Crinoidea Flexi-

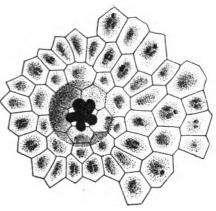


Fig. 4.—Base in Hadrocrinus discus. Remnants of atrophied basals indicated by notches; radials indented by axial canal and covered by column, as shown by the radiating striae.

bilia (pl. 38, fig. 2b), and as to infrabasals by several forms of the Ichthyocrinidae.

The radials and primibrachs are small, succeeded by large plates in the brachial series, which are singularly irregular in form and size. The half rays bifurate on the second secundibrach, which is followed by about four ranges of tertibrachs and one or two biserial pairs of arm brachials before the arms become free. The interbrachials are in six or seven ranges, beginning with a large first plate followed by two, with an extra plate interpolated on the posterior side. A narrow series, rarely exceeding two plates abreast, continues to the zone of the arm bases, but the fourth range consists invariably of a single plate. Similar plates are well developed in the second and third axils.

The calyx plates are smooth, entirely devoid of the intense sculpturing seen in *H. plenissimus*; but they have the very unusual character of broad, shallow median depressions containing smaller pits, which are double or triple on the radial series and single on the interradial, the triple pits being on the axillaries.

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The type and only species of the genus is typically of large size, with calyx shallow and broad, the average diameter of three specimens being about 10 cm.

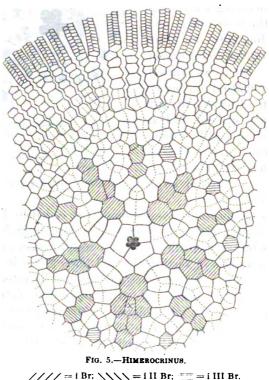
Horizon and locality.—Onondaga (Sellersburg) limestone: Louisville, Kentucky. A fragment belonging to the genus, and perhaps to the type species, has been found in Erie County, western New York.

HIMEROCRINUS, new genus.

HIMEROCRINUS PLENISSIMUS (Lyon).

Plate 2, figs. 2; plate 3, figs. 1-4; plate 4, figs. 1-4.

Hadrocrinus plenissimus Lyon, 1869, Trans. Amer. Philos. Soc., vol. 13, p. 445, pl 26, figs. b 1, b 2, b 3.—Wachsmuth and Springer, 1897, North American Crinoidea Camerata, p. 328, pl. 24, figs. 2 a, b.—Rowley in Greene, Contrib. Indiana Paleontology, vol. 1, 1903, p. 165, pl. 48, figs. 5, 6.



////=i Br; $\backslash \backslash = i$ III Br; ==i III Br. Dotted line = R R and Br.

The genus is founded on Hadrocrinus plenissimus of Lyon⁸, which is the only known species. It attains a very large size, one of the largest of known Camerata, upwards of 20 specimens ranging from 10 to 15 cm. diameter of calyx. From a deep inverted cone involving the basals and radials -which are both large-the wall spreads outward in a graceful reversed curve to the arm bases, forming a broad,

shallow calyx, with a low tegmen composed of innumerable slightly tumid plates, resembling that of the Actinocrinoid genus, Strotocrinus.

The surface is marked by a most profuse and highly sculptured ornamentation, usually in the form of numerous intricate radiating ridges and furrows passing from plate to plate from the radials up which are sometimes broken up into pits less ornately arranged. The higher brachials leading to the free arms are marked by a conspicuous longitudinal ridge, with strong lateral processes. There is considerable variety in these surface characters, but they are too much influenced by conditions of preservation to be available for defining species.

The two special characters upon which the genus is founded are the primibrachs, and the enormous brachial extension of the calvx. These are thoroughly shown by the generic diagram (text fig. 5). While the primibrachs have the normal number of two, instead of a single axillary plate as in Hadrocrinus, they tend to assume an unusual condition, which is the reverse of what is seen in Comanthocrinus. One of the primibrachs is frequently much modified, but instead of the first, as in that genus, it is here the second, or axillary, plate that is unstable. In about half of the specimens it is more or less reduced in size, and singularly changed in shape and proportions, while in others it is of normal size and form all around. In some cases both forms are present in the same specimen. Lyon interpreted the structure of the IBr as being the same as in H. discus. In the intricate sculpture on many of the specimens the sutures are difficult to see, and his type being of that character he did not observe the presence of the two plates, which are evident in upward of 20 specimens. The modification in form of the axillary is seen in the diagram, which is made chiefly from an extraordinary specimen obtained since Lyon's time, having the calvx nearly intact. with a spread of about 15 cm., and the surface characters well preserved from the basal pit to the arm bases. It is finely shown by figure 1 on plate 3.

The irregularity in the axillary is reduplicated to some extent in the succeeding divisions, which are repeated to the number of 3 to 5, exceptionally 6, at intervals of two plates for the first three bifurcations, and longer higher up. After the third axillary the outer ramus of the ray and of the half dichotom remains single, while the inner ramus of the half dichotom branches, so that the number of arms is normally 16 or 17 to the ray, thus making 80 or more arms in all. The final brachial series bears a strong median ridge, and passes into a relatively small biserial arm. The ridges and arm openings are well shown in Lyon's figures b 2, and b 3, and I now have a specimen with the arms preserved for a considerable distance (pl. 4, fig. 1), which in their number and small size are in marked contrast to

the few massive appendages of the *H. discus*. It is in this respect strikingly similar to *Strotocrinus*, which with a greatly expanded calyx has similar small arms, in accordance with the fact, frequently observed in crinoids, that increase in size of calyx is often accompanied by a diminution in size of the arms.

The interbrachial plates are few and large, usually in three ranges of 1—2—1 in the interray, and 2, exceptionally 3, in single series in the second axils, with an occasional plate in the third. The anal interradius has usually an extra plate in the second range, but this may sometimes also occur in other interradii, so the differentiation is not certain.

The column of this genus partakes of a peculiar structure, more fully to be described under *Dolatocrinus*, whereby the nodal colum-



Fig. 6.—Distribution of arms in himerocrinus.

nals are remarkably conspicuous, having a flanged peripheral rim overhanging and sometimes concealing the adjoining internodals, and being studded in varying number with projecting cogs resembling fins, while the internodals are thin and of less diameter.

All the specimens, including some 23 showing the basal cone only, in addition to the

20 above mentioned, seem to belong to the type species, with the possible exception of one. Hall's *Coronocrinus*, from the Manlius of New York, should be compared with this genus.

· Horizon and locality.—The type and only described species is from the Onondaga (Jeffersonville) limestone, at Louisville, Kentucky.

Genus TECHNOCRINUS Hall.

TECHNOCRINUS NIAGARENSIS, new species.

Plate 5, figs. 1, 2.

Among collections made for me in western Tennessee in recent years are two forms belonging to the group under consideration, the occurrence of which carries the age of their genera back to earlier epochs than hitherto known. Technocrinus is typically an Oriskany fossil of the Lower Devonian, found heretofore only in Maryland and New York. It must now be credited also to the Silurian, on the evidence of the single specimen which I have figured under the above name. It was found in place in the Bob formation of the late Niagaran in the first bluff below Cerro Gordo, on the left side of the Tennessee River, in Hardin County, Tennessee; and it was associated in the same layer with Lampterocrinus, which is a thoroughly characteristic Niagaran form. The specimen is in good condition, showing all the generic characters very distinctly, and in addition to these the plates of the dorsal cup are surmounted by small, delicate spines, some

of which may have been movable. Several of these slender spines are shown in the figure, and well-defined shallow sockets are seen at the middle of some plates on which the spines are wanting. The plates of the cup are more or less marked by low connecting ridges, which become more prominent upward. The cup is a broadly rounded ovoid below, with a tendency to contract a little toward the arm bases. There were apparently 20 arms. Dimensions: Height, 20 mm.; width, 30 mm. Spines occur also on one or the Maryland species, T. spinulosus, but in the surface characters and form of calyx it is very different from this.

Horizon and locality.—Niagaran (Bob formation): Hardin County, Tennessee.

Type.—Of this and other new species herein described, Frank Springer Collection in United States National Museum.

Genus STEREOCRINUS Barris.

The other genus which must be set further back in the time scale is *Stereocrinus*, hitherto confined to the Middle Devonian, but which now turns up in the Helderbergian as a well marked species, for which I propose the name:

STEREOCRINUS HELDERBERGENSIS, new species.

Plate 5, figs. 3, 4.

In the material obtained by my collectors, Pate and Braun, from the Linden formation at various localities in Benton County, Tennessee, during a period of several years, were numerous isolated plates of an unknown Camerate crinoid, which by reconstructing a ray from these pieces I identified as Stereocrinus. Afterwards the fortunate discovery of a good calyx near Holliday confirmed the identification. The genus was founded upon specimens from the Hamilton of northern Michigan, and so far as I know it has not been recognized in the Onondaga beds of the Louisville area. In the Michigan form the calyx is strongly lobed in the zone of the arm bases, whereas in the present species there is no interradial depression whatever, and the arm bases form an almost continuous ring. Similar differences occur between species of Dolatocrinus. The plates of the cup in this species as found are usually smooth, with a low median ridge on the radial series, but when well preserved are marked by a sharp and fine The tegmen is evenly convex, appearing too high in the figured specimen on account of pinching, and is composed of smooth plates. The specimen illustrated measures 30 mm. high and 42 mm. in diameter. Isolated plates indicate that a larger size was attained.

There is also fragmentary evidence of the existence of a large species of *Dolatocrinus* in the same beds with the *Stereocrinus*.

Horizon and locality.—Helderbergian (Linden formation): Benton County, Tennessee.

Genus DOLATOCRINUS Lyon.

The definition of the genus sufficiently appears in the antecedent While it is there stated that the anal side is not differentiated, and elsewhere that the symmetry of the dorsal cup is not disturbed by anal structures, these statements must not be taken too literally. While it is true that there are usually on the dorsal side no extra plates analogous to those in the first or second interbrachial ranges of the posterior interradius which are commonly called "anal plates," yet there is unquestionably more or less disturbance of the Dolatocrinus calyx by reason of the position and growth of the intestine, sufficient to produce in the calyx as a whole a certain bilateral symmetry. The anal tube is always decidedly subcentral; and while the interray toward which it inclines may in most cases have no increase in number of plates, a comparison of numerous specimens shows that the posterior interradius is very often appreciably wider than the others, and its plates larger. Little is known of the arms of Dolatocrinus; they having only been seen in two or three specimens, except in the New York species described by Hall as Cacabocrinus troosti, and referred to Dolatocrinus by revisors, which has branching arms, and should stand as a different genus under Troost's name adopted by Hall, or some other. from this, all the species probably have simple, biserial arms, and they must have been extremely fragile.

Dolatocrinus is notable for the prominence of its first interbrachial, which is the largest plate in the calyx, conspicuous alike for its size, and in most species for its elaborate radiate sculpturing. It is usually followed by one or two diminishing plates tandem, while the other plates which appear in the interbrachial areas are fixed pinnulars, some of which are so large as to lose the semblance of their primitive function. This is the case with D. grandis, which has no interbrachials beyond the first, but the space which in other species is occupied by a second interbrachial is taken by two large pinnulars resting in part upon its angular distal face. The genus differs from others having a similar incorporation of pinnules in their order of succession. In Comanthocrinus, with uniserial arms, the pinnulation begins on the second secundibrach, followed by one alternating on the third, and beyond that on both margins of successive brachials. In Scyphocrinus, also uniserial, the succession is alternately on secundibrachs 2, 4, 5, 6, 7, etc. But in Dolatocrinus, with biserial arms, the first incorporated pinnule leads from secundibrach 1, after which the succession is alternately on 2 and 3, and beyond that on each brachial of the biserial pairs.

The column of *Dolatocrinus* has some striking peculiarities not observed in crinoids outside of this group, but which it shares with that of *Himerocrinus*. It is composed of very thin columnals, some

of which (the internodals) are plain disks of uniform thickness for their full diameter: alternating with these at different intervals are other columnals (the nodals) also thin in their median portions, which are of greater diameter than the former, and have at their circumference a flange which projects at either side like the tire of a wheel, to a width at least equal to the thickness of one internodal. Thus two nodals may abut at the exterior by their flange-like rims so as to arch over the intervening internodal and completely conceal it from view; or, a greater number of internodals may be interposed, up to 6 or 8 or perhaps more, in which case the nodal stands out in relief, conspicuous by its higher level and greater thickness. thermore, the nodals themselves are surmounted by certain singular fin-like cogs transverse to their periphery—that is, longitudinally parallel to the column. These occur to the number of three, five, or sometimes more, to each nodal, of which those of successive nodals may or may not coincide in position; if they do, the column takes on an angular outline. The cogs may be limited to the width of the nodals to which they are attached, or they may extend either way for the span of several internodals, perhaps in some cases connecting and forming continuous serrated longitudinal ridges along the column. Some of these cog-like projections are relatively high, even equaling the diameter of the column, and they evidently in some cases form a continuation of the knife-edged ridges on radials and primibrachs in forms like D. spinosus, D. marshi, etc. Owing to the thinness of the columnals, the peripheral flanges of the nodals are held by a weak connection, so that in the fossils they may often be broken off, leaving only a continuous series of columnals of the same size as the internodals (pl. 9, fig. 3).

Specimens with any portion of the column attached, or even any considerable length of detached columns, are extremely rare, so that we have little information as to the distribution of the nodal columnals throughout the stem as a whole; but from the fragments available, and from analogy with the mode of growth of the stem in the crinoids generally, it is probable that in the proximal parts of the stem the nodals are contiguous and conceal the interpolated internodals under the arch formed by their flanges, while toward the distal end the internodals increase in number, and the intervals between the nodals become longer. Thus in the part of the stem proximal to the calvx shown in figure 2 of plate 10 the nodal columnals are in close contact, concealing the internodals which may be seen at the broken extremity, and the projecting cogs form continuous ridges. In figure 1 there are gaps between the nodals in which internodals are seen, and the cogs do not always coincide in alignment, both of which may be due to disturbance after death. In various sections of stems figured on plates 9 and 10 the intervals in their natural condition are shown, some with as many as 12 internodals, which were probably from the distal portions. Among these fragments also are shown some good examples of the form and proportions of the nodal columnals, and of the cog-like processes, as above indicated.

Sections of stem from near the root are found having strong radicular cirri more or less radiately arranged; and in two instances, clearly belonging to this genus, a cirrus appears in place of one of the cog-like processes, which suggests the idea that these outgrowths of the nodal columnals are analogous to cirri.

Lyon observed this peculiar type of column, and gave a description of it, with a figure, in his paper of 1869 in the Transactions of the American Philosophical Society (p. 451, pl.. 26, fig h); but with the terms he used his description is rather hard to understand.

There is in the species of this genus a marked instability in the form and proportions of some of the principal calvx plates, as well as in some other characters. There is much variation in size of the radials, brachials, and interbrachials, not only among different specimens of the same species, but also among the different rays of the same specimen, so that the relative shape and size of these plates are of little value in the definition of species. Even in some of the best defined and most constant Onondaga species, such as D. spinosus, we find the conspicuous first interbrachial undergoing change from broadly truncate above to elongate and almost acuminate, without apparently affecting any of the other characters; and in D. lacus the number of interbrachial ranges may vary among specimens otherwise almost counterparts. Many other examples could be cited, including abnormal specimens, rather frequent, especially in Hamilton species, such as those with four rays, with a sixth plate in the radial circlet, etc.: and the instability in these and other respects must constantly be taken into account in considering the definition or identification of species of this genus.

Genotype.—Dolatocrinus lacus Lyon.

Distribution.—Onondaga: Louisville area, and Ohio; perhaps Helderbergian, Tennessee.

THE SPECIES OF DOLATOCRINUS.

In the following discussion of *Dolatocrinus* and its species there will be frequent reference to a few works for which it may be convenient to use abbreviations; these are:

MILLER and GURLEY. Bulletins 4 to 12 of the Illinois State Museum, 1894 to 1897. Cited: "Miller and Gurley, Bull. 4, 1894, etc."

WACHSMUTH and SPRINGER. North American Crinoidea Camerata. Memoirs Museum of Comparative Zoology, Harvard, vol. 20, 1897. Cited: "Wachsmuth and Springer, N. A. Crin. Cam. 1897."

ROWLEY; in GREENE. Contribution to Indiana Paleontology, vol. 1; issued in 20 parts, Feb., 1898, to Sept., 1904, continuously paged, pp. 1-204, plates 1-60; and three parts of vol. 2, July, 1906, to Nov., 1906, pp. 1-38, plates 1-9. Cited: "Rowley in Greene, 1903, etc."

The genus Dolatocrinus is remarkable among all Camerata for the extraordinary number of species which have been described under it from a single horizon within a small local area. The total number of named species and varieties for all areas is 77, all from the Middle Devonian, of which 15 are from the Onondaga and 62 from the Hamilton. Sixty-five belong to the Louisville area, and of these, 49 species and 4 varieties are described from the Hamilton alone. The crinoid-producing exposures in the Hamilton beds of this area are of very limited extent, being confined principally to a few miles opposite Louisville, and along Silver Creek and other streams in Clark County, Indiana, from which the types of nearly all the 53 alleged species and varieties have been derived. The specimens are almost never found with any part of the arms attached, and we know nothing of the structures distal to the calvx, except that the arms are biserial and probably always simple. Hence the descriptions are necessarily restricted to characters observed in the calyx alone, which in this genus is of the most simple construction, having a nearly pentamerous symmetry, so that we are without the benefit of characters for discrimination usually afforded by the presence of anal structures. The slight differences occasionally noticed in the second or third ranges of interradial plates are inconstant and mostly

The occurrence of such an incredible number of species of one genus, from a single horizon at the same locality, is in the highest degree improbable; and the statement of the foregoing facts alone is sufficient to put the list under suspicion. It is of importance that the character of the crinoidal fauna of this celebrated locality should be correctly understood, in order that authors and students may not be misled into erroneous conclusions regarding it.

The greater part of this multiplication of specific names is due to the activities of Miller and Gurley, who, during the years 1894–1897, published in the Bulletins of the Illinois State Museum 37 species of Dolatocrinus from the Hamilton beds alone, in addition to four from the underlying Onondaga, all from the vicinity of Louisville. By the work of these authors, chiefly in the publications mentioned, and of Mr. Miller alone in the reports of the Geological Surveys of Missouri and Indiana, several hundred species of crinoids and blastoids were described and illustrated, mainly from specimens in the rich collection accumulated by Mr. Gurley, which he afterwards placed at the service of science by donating it to the Walker Museum of the University of Chicago. By these means a great number of

new and instructive forms were brought to light, and a valuable addition was made to our knowledge of the prolific crinoidal faunas of the interior continental basin. Most of the specimens were obtained by Mr. Gurley through purchases from local collectors, some of whom were not geologists, and sufficient care was not always taken to determine the exact horizon from which they were derived; so that in several instances the stratigraphic position assigned to the species in the published descriptions is not correct. This is notably the case with some of the most conspicuous forms of the Louisville area.

Subsequently Mr. George K. Greene, the veteran collector at New Albany, Indiana, on the Ohio River opposite Louisville, published a series of pamphlets extending through the years 1898–1906, which collectively formed the volumes entitled: Contribution to Indiana Paleontology, for the purpose of illustrating his extensive collection of corals and crinoids—the work upon the latter being intrusted to Prof. R. R. Rowley, of Louisiana, Missouri. This resulted in the proposal of 16 new species and varieties of *Dolatocrinus*, likewise all from the Louisville area.

The type and another early species had been published by Lyon, and seven others from New York, Canada, and Michigan by Hall, Whiteaves, and Barris, respectively. Of those published by Wachsmuth and Springer in their Monograph of the North American Crinoidea Camerata in 1897, some had been anticipated by the descriptions of Miller and Gurley while that work was going through the press, and it is necessary for the correctness of the record that the synonymy of these should be definitely stated. Two species from Michigan were published by Miss Elvira Wood in 1904. I am informed that at least two new species and as many varieties from New York are to be published by the State museum; and I am reluctantly compelled to swell the list by adding four new names on my own account.

Recurring again to the numerous Hamilton species published by Miller and Gurley: In order to facilitate the describing of species, they at the outset laid down as an ironclad rule that the number of arms alone should constitute an invariable specific character, so that

[•] The differences in the known crinoidal faunas of the several Hamilton areas of the Middle Devonian of this continent are very striking. At Louisville Delatocrinus is the leading genus, followed by Megistocrinus, Nucleocrinus, Codaster, etc., but no sign of Melocrinus or of any Flexible crinoid; in Callaway County, Missouri, Melocrinus occurs, and an Ichthyocrinoid of the genus Dactylocrinus, but no Dolatocrinus or Megistocrinus; in Iowa Megistocrinus and Melocrinus and a notable new Ichthyocrinoid, but no Dolatocrinus in northern Michigan, Dolatocrinus, Megistocrinus, Nucleocrinus, and Codaster, of species mostly well differentiated from those of the Louisville area; in Wisconsin, Melocrinus closely similar to the Missouri species, forms which also extend far to the north in the McKenzle Basin, Canada; in the last four areas, not including the Canadian, species belonging to the Flexibilia occur, of different forms in each. In western New York and Ontario, Dolatocrinus and Megistocrinus closely related to the Louisville forms occur; but in addition to these an extraordinary assemblage of other forms not represented in either of the other areas, which are soon to be described in a Memoir by the the New York State Museum.

by this means they were relieved of the trouble of comparison with species otherwise similar, which they usually declared to be unnecessary. Thus in Bulletin 8, page 46, in describing *D. charlestownensis*:

It is, of course, unnecessary to compare it with any other described species, because the arm formula alone distinguishes it.

This plan placed the describing of species upon a sure mathematical basis; but it had its limitations. The range of variation in number of arms in a single otherwise constant form of *Dolatocrinus* may be from 10 to 20, which was soon in danger of being used up. So the authors went a step farther, and evolved another scheme of infinite possibilities, namely, that not only is the number of arms an invariable specific character, but also the mode of grouping of the arms among the five rays—so that newly acquired specimens not otherwise distinguishable from species already described could readily be made the types of new species upon this character alone. Thus they say in the ninth Bulletin, page 47:

This species is distinguished from all other 16-armed species * * * by the arm formula. For example, the arm formula in D. coelatus is 4-4-2-2; in D. nodosus it is 4-3-3-3; in D. salebrosus it is 4-3-2-3-4; in D. arrosus it is 4-4-3-3-2.

And on page 51:

It can be of no service to compare this with any species having a different arm formula, for that alone distinguishes it.

The beauty of this plan will be evident when we consider that if we take only the most usual variations, caused by the addition of one or two arms, thus giving 2, 3, or 4 arms to the ray, there would be 120 different permutations of these numbers among the five rays of a crinoid, each of which under the authors' latest rule would establish a distinct species; that is to say, 120 species under any otherwise defined form. Every one of the dozen or more recognizable Hamilton forms of that locality may exhibit similar variations in number and arrangement of arms; so that with sufficient collections there would be as the logical result of this process, consistently followed up, about 1,500 possible species of this one genus, in a single formation 8 feet thick, and at the same locality.

Now it is a fact abundantly established that a character which is available for the differentiation of species in one group or genus, or in one formation or locality, may as a result of different conditions be utterly worthless in others. This is notably true in regard to the number of arms in the crinoids. Among the recent forms, especially the comatulids, variation from 10 to 20 arms is not uncommon, while on the other hand a definite number of arms is constant for many large groups.

In certain prolific and extremely well-marked Carboniferous species, such as *Macrocrinus verneuilianus* and *Dizygocrinus rotundus*, there is a considerable range of variation in number of arms (which

Miller and Gurley utilized, however, by making new species for all of them), whereas in many other Batocrinoid genera the number is generally constant for the species. Among the Onondaga species of Dolatocrinus the number of arms appears to be usually constant and well correlated with other characters. In the Hamilton the genus reached its acme of development, resulting in an enormous increase in number and variety, followed, as usual in such cases, by extinction. It was a period of active mutation. Several extremely well-marked types were produced, which may readily be distinguished from the Onondaga forms and from one another. Some of these, which no experienced paleontologist would fail to recognize at a glance, include variations in number and grouping of arms and in minor details of surface ornament which, if regarded as essential, would result in making a new species for almost every well-preserved specimen that turns up. In fact, that is what actually occurred as to a large part of Miller and Gurley's Hamilton species; for in the Gurley collection. containing all the material used in their study of this genus, 18 of their species are represented only by the single type specimen, there being no duplicates except in the other 19. And to show how the use of the arm character would work out in practice, there are in my own collection upward of 20 specimens belonging to the most prolific Hamilton form of the locality which have arm formulas different from that of any of Miller and Gurley's species, and every one of them, under their rule, would have to be made the type of a new species.

The recognition of the several well-defined and definable Hamilton types will result in the reduction of the species to a reasonable number, within the bounds of probability. I shall attempt to point them out, and to give the names which by reason of priority should be attached to them. Much of the matter contained in the lengthy descriptions (often tedious repetitions of generic characters) is of no practical service for the discrimination of the species. For any valid species it ought to be possible to point out some one definite character, or combination of characters, not due to individual variation or sporadic occurrence, by which it is distinguished and contrasted with others. Supposed species for which this can not be done should be merged in the nearest one that is well defined.

The characters which have been chiefly considered in the differentiation of species in this genus are the following:

Form.—The general form and proportions of the calyx are useful characters which mark several well-defined types. It may be rather high cup-shaped, with vertical sides and flat base; bowl-shaped or hemispheric, expanding by a regular curve from a narrow base to the arms; basin-shaped, with nearly straight sides, spreading at a wide angle from a truncate and concave base; depressed bursiform, constricted below the arm bases, the sides curving inward to a broad

flat or concave base. Along with these various shapes, but not always concurrently with particular forms, the tegmen may vary from nearly flat to convex or conical; deeply lobed or sloping evenly; with plates well defined, or rather obscure on the smooth surface; with surface granular, covered with small pustules, sharp or rounded nodes, or strong spines. The base may be sharply excavate into a deep or shallow pit enclosing the column, broadly concave, flat, or protuberant. In some forms the tegmen is remarkably constant and characteristic; in others, especially the large bursiform type, it is subject to much change due to pressure in fossilization.

Surface ornament.—There are upon the plates of the dorsal cup two kinds of sculpturing: (1) A longitudinal median ridge following the radial series, which may be limited to a few of the lower plates or may traverse the entire distance to the arm bases; may be low, rounded, inconspicuous, or high, sharp, and very prominent; or it may be absent altogether. It is formed with nodes at the centers of the plates as nuclei, which may be elongated until they connect at the sutures, or may be connected by a rounded neck; if the connecting neck approaches the size of the nodes, the ridge may be called continuous, and if very much smaller and inconspicuous, it may be called discontinuous. Again, the central nodes may be substantially isolated, but even then there is usually some trace of a connection marking the course of the buried nerve cords. (2) A secondary sculpturing which consists of more or less continuous radiating striae, straight or wrinkled, or lines of small pustules, passing from plate to plate, tending to form concentric triangles; or of nodes or pustules not radiately arranged. Primarily the ridges connecting the centers of both radial and interradial sets of plates are the external representatives of the nerve cords which innervate the growing skeleton, and the triangular arrangement results mechanically from the mutual relations of the plates. With age they may become variously modified by secondary growth, reduplicated, intensified, or broken up into nodes by which the original fine lines are interrupted, obscured, or obliterated. These processes will produce extremes of the two types of sculpture, between which there may be an infinite number of combinations in which the two are more or less intermingled. Sometimes the striae are bent or wrinkled, making a vermicular kind of ornament; and in some cases there are neither definite striae nor nodes, but all plates are tumid and radiately furrowed. If certain lines of the triangles are accentuated, a stellate figure is produced around the base. On account of intergradation between the different types, too much importance must not be attached to the surface ornament. Even Miller and Gurley had some doubt about it, for they said in Bulletin 4, page 25:

We are satisfied the sculpturing is not uniform on specimens belonging to the same species.

Nevertheless they afterwards often stated as to a new species that it "differs from all others in surface ornamentation and number of arms." Unless fairly definite stages of these surface modifications can be correlated with some other character, I am unable to regard them as of much practical value in the discrimination of species. (See further under *D. incisus* and *D. asperatus*.)

So-called "azygous side."—This was Miller's term for what other authors usually call the posterior, or anal, interradius. In this genus that side is usually not differentiated in the dorsal cup by any increase in the number of plates, but may be in some cases by the greater size of corresponding plates. The first and second ranges of interbrachials consist normally of one plate each, from which number they rarely vary; slight differences occasionally occur in the third range, but these are sporadic, not constant for the species, and may be disregarded in the descriptions.

Pinnule openings; "ovarian apertures"; or "pores."-Much has been said in the specific descriptions about the openings through the calvx wall which occur in varying numbers in the zone of the arm bases. They have been called "ovarian apertures" by Miller and Gurley, and "respiratory pores" by Wachsmuth and Springer. As already stated, I have elsewhere 10 shown by conclusive evidence of specimens in which the parts are perfectly preserved that these slit-like openings or pores, which occur also among the Batocrinidae, Platycrinidae, and the non arm-branching Camerata of other families, are the openings for pinnules which are to a greater or less extent incorporated in the calyx, and emerge directly through the wall along the margin where the dorsal and ventral structures meet, analogous to the oral pinnules of the Recent crinoids. It is probable that they occur in all species of Dolatocrinus, unless perhaps in some where the arms become free directly upon the first secundibrach. In several cases where the species were described as without "ovarian pores," subsequent inspection has disclosed their presence; and their apparent absence in any specimen may be due to their being obscured by silicification or covered by matrix, or to their inconspicuous occurrence. They differ in shape and size in different species or groups of species; in some they are indicated by long slits, well exposed and visible at a glance; in some they are very small and lie close under the edge of the arm, but are absent in the wider space between the rays, in which case, especially when there is a rugose surface, they are hard to see.

The clongate slits represent the ambulacral grooves leading to the openings, from which the minute covering pieces have fallen away, a shown by figures 4 and 10 on plate 1.

¹⁰ On the genus Scyphocrinus, 1917, pp. 33-37; 40-46; pl. 9, figs. 5a, b, 6; see also pl. 1, figs. 4, 10, and pl. 2 figs. 3, 4, herein.

The number of visible openings depends upon the extent to which brachials are incorporated, as has been shown in regard to the two species of Comanthocrinus. If the arm becomes free on the first secundibrach, there may be no pores through the calyx wall, or only a single one at one or both sides of the arm-base; if higher secundibrachs are incorporated, the number correspondingly increases. D. grandis (pl. 7, figs. 2, 5) the biserial arm is incorporated for a distance of several pairs of brachials following the third secundibrach; a fixed pinnule leads from IIBr, on the outer side of the dichotom, followed by one on IIBr, inner side, next by one on IIBr, outer side, and then by one for each margin of the biserial pair, each of which leads to an opening. Therefore when one pair of brachial ossicles succeeding IIBr, are incorporated, there will be 6 pores between the rays and 4 between their divisions; and with further incorporation of arm brachials the number of openings will be increased to 8, or even 12. In D. bulbaceus only one small pore is present for each arm; in stellifer and amplus there are always 2 for each arm, and from 2 to 4 for each interradius.

Number of arms.—With the foregoing category of available characters to choose from, it ought to be practicable to find correlations of sufficient constancy to define the species without resorting to anything so purely arbitrary as the number and grouping of arms. standing alone, in forms where this character is clearly subject to great individual variation. I do not wish to be misunderstood on this point, and it must not be supposed that I am denying the importance of the number of arms as a general proposition. On the contrary, it is a character of great value and of wide application, representing as it does progressive stages in the ontogeny of the crinoids which often become fixed, and furnish decisive criteria in the separation of groups. The entire Larviformia division of the Inadunates is characterized by having the arms in the primitive stage, without any axillary plate in the ray, and therefore five in number. The change in other groups from 10 to 20 arms, due to a second bifurcation in all the rays, indicates a certain progress in calvx development by increase in ray capacity that probably correlates with other facts. Where the change is of less degree—such, for example, that only one of the two arms in each ray bifurcates-but according to a definite plan, it may be a good character. instance, the 15 arms, 3 to each ray, of D. triangulatus of the Michigan area, constant as I have it in 23 specimens, and correlated with a definite form and proportion of calvx and style of ornament, is a good character to help distinguish it from somewhat similar forms having a constant number of 2 or 4 arms to a ray. The 10 arms of D. grandis is a perfectly reliable character as against the 20 arms of D. spinosus, or the 30 arms of D. exstans, or the 40 of D. multi brachiatus. But if a specimen of D. spinosus happened to have

19 or 21 arms, or one of *D. multibrachiatus* 37 or 43, that would not make them different species, since the general morphological condition would remain the same. It is even true that in some groups species are marked by increase in the number of arms occurring in less than all the rays, as in *Agaricocrinus* and *Megistecrinus*, where the arms may be variously grouped, yet the groupings are according to a definite plan, having a certain relation to the bilateral symmetry of these crinoids. But it is in forms of simple construction like *Delatocrinus*, when the change in number of arms from 10 or more to 20 or less is effected by the addition or subtraction of one or two arms in one or more rays at random, without any definite order or system, and this in forms otherwise similar, that such differences must be wholly disregarded in the definition of species.

The crinoids from Louisville and vicinity of Onondaga age have been derived chiefly from rocks exposed at the Falls of the Ohio River which lie below the hydraulic limestone, being of a formation of crystalline limestone 20 to 30 feet thick, now known locally as the Jeffersonville limestone. Those of the Hamilton are from the upper part of a limestone formation, 8 feet thick, called the Sellersburg limestone, of which the most productive exposures are along Silver Creek in Clark County, Indiana, above the hydraulic limestone. Bear Grass Creek on the Louisville side was in former years a wellknown locality for Hamilton crinoids, from which many fine specimens were obtained by the early collectors. For a lucid account of the stratigraphy and local occurrences of the region see Dr. R. S. Bassler's paper of 1908 on The Nettleroth Collection of Invertebrate Fossils.11 For convenience I use the expression "Louisville area" to designate the general locality, including the Falls of the Ohio and the exposures on both sides of the river at Louisville, and along Silver Creek in Clark County, Indiana.

The relations of the recognizable species are shown by the subjoined analytical keys, the Onondaga and Hamilton species being treated separately. Following these I have listed the species for the respective formations with the synonyms under each. The number of species is thus reduced to 12 for the Onondaga and 23 for the Hamilton. To avoid needless repetition, it should be noted that the types of Miller and Gurley's species (except three that were lost) are in the Walker Museum at the University of Chicago, and those of Rowley are in the American Museum of Natural History in New York; and that all the species described by both these authors are from Louisville, Kentucky, and vicinity. The types of Hall are in the American Museum; those of Miss Wood in the United States National Museum; and those of Lyon, Barris, Wachsmuth and Springer, as well as the new material here figured, are in the author's collection, now in the United States National Museum.

¹¹ Smithsonian Miscellaneous Collections, vol. 52, p. 2, pp. 121-152.

ONONDAGA SPECIES.

[Valid species in italics; synonyms in roman.]

With 10 arms.	
Calyx small.	
High cup-shaped, with broadly truncate base; central nodes small.	
Radiating striae few and coarse.	
Tegmen low; pinnule openings prominent.	
Sides of cup nearly vertical	D. lacus.
• •	-approximatus.
Sides of cup sloping inward from broad base	
Depressed basin-shaped, sides sloping outward; broadly	
curving base with small pit.	
Radiating striae or wrinkles fine and numerous; radial	
ridges low or wanting; no nodes	D. ornatus.
Surface smooth; tegmen and cup evenly rounded to a	
globose contour	us, new species.
Calyx medium sized.	•
Doubly conical, with broad base; sides sloping at wide angle	
to arm bases; sharp median ridge on radials and IBr.	
Radiating striae coarse or wanting.	
Tegmen rather low	D. speciosus.
Radiating striae fine and sharp.	•
Tegmen higher; pinnule openings prominent	D. marshi.
Calyx large, subhemispheric.	
Base truncate, deeply excavate, involving all of radials;	
iBr single, angular above, followed by two plates which	
are pinnulars; median ridge on radials and IBr obtuse	
or absent; surface of cup-plates strongly wrinkled. Teg-	
men high convex; pinnule openings large and numerous	D. grandis.
,	-excavatus.
Y	ar. unicarinatus.
	fossatus.
With 20 arms.	
Calyx large.	
Base shallow concave, with small pit; cup-plates orna-	
mented with fine radiating striae; median ridge on radial	
series strong, keel-like.	
Tegmen moderately convex; pinnule openings few and	
prominent.	
Median ridge confined to radials and IBr. Teg-	
men bearing strong spines	D. spinosus. —curriei.
Median ridge continuing to arms. Tegmen without	
strong spines Insufficiently defined; similar to spinosus in dorsal	D. insuetus.
cup, but tegmen unknown	D. lamellosus.
Base broad and flat, with shallow pit not including radials;	
surface smooth, small node or spine on IBr, exceptionally	
a keel-like ridge	D, major.
183081213	

With more than 20 arms.

Calyx large.

DOLATOCRINUS LACUS Lyon.

Plate 5, figs. 6, 7.

Dolatocrimus lacus Lyon, Geol. Surv. Kentucky, vol. 3, 1857, p. 482, pl. 41, figs. 2a-e.—Billings, Canad. Org. Rem., Dec. 1, 1858, p. 29, text-figs. 13-18.—Miller and Gurley, Bull. 4; Ill. St. Mus., 1894, p. 9. pl. 1, fig. 4.—Wachsmuth and Springer, N. A. Crin. Cam., 1897, p. 311, pl. 261, figs. 6a-c.

Dolatocrinus approximatus MILLER and GURLEY, Bull. 4, 1894, p. 25, pl. 3, figs. 4-6.

This, the type species of the genus, has been thoroughly described and illustrated in the literature. The chief points to observe are its almost rectangular outline in vertical section, the broad and flat base, and relatively high calyx with low tegmen; the ornament is by small central nodes on the lower plates, and a few prominent raised lines, producing distinct stellate figures. The species is rather below medium size, ranging from 15 to 20 mm. high and 20 to 25 wide. In typical specimens the height to width of calyx is about as 1:1.25, and the width at the flattened base about equal to that at the arms; but there is variation from this to 1:1.5, the lower forms of greater width having more curvature at the sides and relatively narrower base; there is also variation toward fine instead of coarse radiating lines upon the plates. A remarkable enlargement of the base in some specimens beyond anything heretofore known in this group seems to indicate a distinct allied species, *D. pyramidatus*.

Throughout all these variations one constant character prevails, which always arrests attention, and that is that the two or three secundibrachs, with sometimes a biserial pair of arm-ossicles, are incorporated in the calyx in such a way as to produce four conspicuous pinnule openings in each interradius, and two, rarely four, in the spaces within the rays; in the latter case they are more crowded. These prominent pinnule sockets, and the broad flat base, give to the crinoids of this type, notwithstanding their small size, a very characteristic aspect.

Horizon and locality.—This form occurs both at Louisville and in the Onondaga limestone at Columbus, Ohio; and the 30 specimens which I have from the two localities conform closely to the type, subject to the variations mentioned; they show no tendency to modification in the normal number of 10 arms, the solitary specimen on which Miller and Gurley based their 11-armed synonym, approximatus, being a mere sporadic occurrence.

S. S. Lyon gives the horizon of *D. lacus* as "above the hydraulic beds," but says that some specimens occurred at the base of the hydraulic limestone. All the specimens in the Lyon collection when I purchased it, including the type, were labeled "Upper Helderberg;" and Colonel Lyon's son, Victor W. Lyon, who collected many of them, said that to his personal knowledge they came from the "upper part of the *Nucleocrinus* bed." George K. Greene labeled all the specimens which I obtained from him as "Upper Helderberg;" and the occurrence of the species at Columbus, Ohio, confirms the horizon as Onondaga. The statement in Lyon's text must have been due to oversight or confusion of notes.

DOLOTACRINUS PYRAMIDATUS, new species.

Plate 5, figs. 8-11.

Of the type of *D. lacus*, but with base enlarged to a width greater than that of the calyx at the level of the arms, so that the slope of the nearly straight sides is inward at less than a right angle. The first primibrach and first interbrachial are bent inward below to form a part of the flat base, the calyx resting upon the small nodes upon these plates. This very unusual contour occurs in three well marked specimens; the largest of them, which abnormally lacks an arm in one ray, is about 22 mm. high by 28 mm. wide at the arm level, and 31 at the base. Pinnule pores are very conspicuous, 2 and 4 to the interspaces.

Horizon and locality.—Onondaga (Jeffersonville limestone): Louisville, Kentucky.

DOLATOCRINUS ORNATUS Meek.

Plate 6, figs. 1-4,

Dolatocrinus ornatus MEER, Proc. Acad. Nat. Sci. Philadelphia, 1871. p. 57.— MILLER and GURLEY, Bull. 4, Ill. St. Mus., 1894, p. 181, pl. 2. figs. 7-9.

Described by Meek without illustration, but well figured by Miller and Gurley, their figure corresponding in all essentials with the type in Columbia University, which is here figured for the first time. The species is not uncommon in the Onondaga rocks at Columbus, Ohio, and I have it also from western New York. From the Ohio locality I have a number of good specimens, averaging somewhat larger than that of Miller and Gurley's figures. It is, however, typically a small species, and differs decidedly from the other small Onondaga species, D. lacus, in the relatively lower, broader, and less angular calyx, and in its peculiar sculpturing by means of very fine radiating costae, which become bent and wrinkled in various ways, producing a sort of vermicular style of ornament. In most specimens a low continuous radial ridge is defined, but in some it is entirely wanting. The tegmen is remarkably constant among the

specimens both of the original species and the variety, being broadly and rather deeply lobed, and covered over the entire surface with numerous small projecting tubercles. One little point peculiar to this species is a sort of overhanging lip from the edge of the tegmen between the rays; it seems to be present in all the variations.

This form persisted into the Hamilton, where it increased in size, and underwent some striking changes in surface markings, while retaining with thorough constancy the chief distinguishing characters of the type. This was described by Miller and Gurley as a variety, asperatus, but in view of the difference in horizon, it is better treated as a species, and it will be listed as such under the Hamilton.

Horizon and locality.—The type of D. ornatus is in Columbia University; and the species is from the Onondaga limestone at Columbus. Ohio, and in western New York.

DOLATOCRINUS ROTUNDUS, new species.

Plate 5, figs. 12, 13.

This species is founded upon a single specimen, of a type differing from all others in having a perfectly round calyx, without angularities or projections of any kind; the surface is smooth, and there is no lobing, or depression, except a slight one for the column facet. It has 10 arms; although surface preservation is good, pinnule openings are not discoverable between the arm bases. The dimensions are 25 mm. high by 30 mm. wide, being slightly contracted vertically; 17 mm. of this height is from the base to the middle of the arm openings, leaving the tegmen low in proportion to the total height. The specimen is in good condition, and these characters must be accepted as definite structures, there being no other species of which it can be considered a variant.

Horizon and locality.—The type specimen came from the Onondaga (Jeffersonville) limestone at the Falls of the Ohio River at Louisville, Kentucky, below the hydraulic limestone.

DOLATOCRINUS SPECIOSUS (Hall).

Cacabocrinus speciosus HALL, 15th Rep. New York State Cab., 1862, p. 109 (137) Dolatocrinus speciosus, Wachsmuth and Springer, N. A. Crin. Cam., 1897, p. 323 pl. 26, figs. 4a, 6.

Hall gave no figures of the several species described by him in the fifteenth report under *Cacabecrinus*, but this one was well illustrated by Wachsmuth and Springer from a somewhat eroded New York specimen answering the description. In form of calyx it represents a type that might be called doubly conical, sloping both ways from the zone of the arms, and truncated at the broad base, where the width is about two-thirds that at the arm level. The wide, rather angular, outward slope of the sides from the plane of the base gives a basin-shaped contour distinct from that of most of the other species.

The dorsal cup is relatively low, scarcely higher than the tegmen, with a shallow concavity at the bottom leading to a small basal pit. Plates low convex, with smooth surface, and a sharp, abruptly rising median ridge (not well preserved in Wachsmuth and Springer's specimen) upon the radial series extending to the arm bases. Tegmen rather high, composed of large, smooth plates, with broad and shallow interámbulacral depressions. Arms 10. It is large-sized species, typical specimens being about 24 mm. high, and 36 mm. wide, and average height to width about 1:1.4.

Horizon and locality.—Onondaga limestone: Schoharie and elsewhere in New York.

DOLATOCRINUS MARSHI Lyon.

Plate 5, fig. 14.

Dolatocrinus marshi Lyon, Trans. Amer. Philos. Soc., vol. 13, 1869, p. 461, pl. 27, figs. n, n', n.2—Miller and Gurley, Bull. 4, Ill. St. Mus., 1894, p. 12, not pl. 1, fig. 8—D. grandis.—Wachsmuth and Springer, N. A. Crin. Cam., 1897, p. 312, pl. 26, figs. 1a-d.—Rowley in Greene, 1903, p. 159 (not pl. 47, figs. 7, 8—D. grandis).

Of the type of D. speciosus, with a similar high, abruptly rising radial ridge continuous to the arm bases, but with rather more angular sides, higher tegmen having a few small scattering tubercles, and a strong dorsal ornament by fine radiating striae. It is on an average of smaller size, and height to width is about 1:1.3. The entire facies of this form bears a strong resemblance to that of the New York species, the figured specimen of which might conceivably be a much eroded specimen of this. If a well-preserved New York specimen showed distinct radiating striae upon the radial and interbrachial plates, I should not know how to separate the species. redescription and figure of this species by Miller and Gurley were based upon a small specimen of D. grandis, and are erroneous and misleading in every particular; Rowley followed their example, but afterwards made a new species for his specimen. Those of Wachsmuth and Springer were made from Lyon's very perfect type specimen, now in my possession.

This species was for a long time extremely rare, but I obtained in recent years a number of additional good specimens which confirm the type, but indicate some variation in size by way of increase to a maximum of 35 mm. high by 50 mm. wide, one-half larger than the usual size. From these it is seen that secundibrachs to the number of three are incorporated, followed by one or more biserial pairs, producing four to six conspicuous pinnule openings to the interbrachial spaces, and giving an appearance at the arm bases analogous to that of *D. grandis*, by which Miller and Gurley were probably misled.

Horizon and locality.—Onondaga (Jeffersonville) limestone: Louisville, Kentucky, and vicinity.

DOLATOCRINUS GRANDIS Miller and Gurley.

Plate 7, figs. 1-8; plate 9, fig. 5; plate 10, fig. 2.

Cacabocrinites sculptus Troost MS., Proc. Amer. Assn. Adv. Sci., 1850 (read 1849), p. 60; Bull. 64, U. S. Nat. Mus., 1909, p. 55.

Dolatocrinus grandis MILLER and GURLEY, Bull. 4, Ill. St. Mus., 1894, p. 14, pl. 2, figs. 4-6; pl. 1, fig. 8 (as D. marshi).—Wood, Bull. 64, U. S. Nat. Mus., 1909, p. 55, pl. 12, fig. 2.

Dolatocrinus excavatus Wachsmuth and Springer, N. A. Crin. Cam., 1897, p. 321, pls. 25, fig. 1, and 26, figs. 7, 8.—Rowley in Greene, 1903, pp. 134, 145, 191.

Dolatocrinus grandis, var. incarinatus Rowley in Greene, 1903, p. 112, pl. 35, figs. 1-3.

Dolatocrinus marshi Rowley in Greene, 1903, p. 159, pl. 47, figs. 7, 8.

Dolatocrinus fossatus Rowley in Greene, vol. 2, 1906, p. 7, pl. 3, figs. 1-3.

This splendid species is most appropriately named, not only on account of its large size, but of the decisive way in which it stands out among all species of the genus, so perfectly distinct that there is no other with which it could be confused. The specimen upon which it was described, while excellent in some respects, was not in condition to exhibit all the characters, especially those of the base, and it is therefore necessary to give some further illustrations.

The species is remarkable for the extent to which the base is excavated and indented by the huge column facet. While the calyx wall curves inward to form a broad concavity on the dorsal side, within this there is sunken a large and very deep pentagonal pit involving the whole of the radials, the upper margins of which form the angular edge of the pit, and at the bottom of which, at about the level of the arms, lie the rather small basals, buried under at least half an inch of column when in place.

It is also remarkable for the manner in which the two large biserial arms of the ray are incorporated in the calyx, coincident with the fixation of pinnules, so as to produce an unprecedented number of pinnule openings directly from the calyx before the arms become free, there being as many as 8 to 12 in some interrays. The number as observed in practice often depends upon the depth to which the arm is broken away in the fossil.

The species also differs from all others in having the first interbrachial 10-sided, so that the upper face is angular and supports two large plates in the second range instead of a single one, as is the case normally in all other species of the genus so far as known. These two plates succeeding iBr₁ were formerly supposed to be interbrachials, but with our present understanding of the mode of succession of the incorporated pinnules, it is clear that they are the first pinnulars of the fixed pinnules which lead from the first secundibrachs, and that this species has actually no interbrachials beyond the first. In the exceptional cases where the iBr₁ is truncate, the

single plate which follows it in turn supports the two large pinnu-This character of two so-called second interbrachials is thoroughly constant for the species, and is one by which it is readily identified from a fragment, the very few exceptions being clearly. sporadic. I have 32 specimens with the plates of the dorsal side preserved, and in only three of them is there a reduction (in some interrays, never in all) of these plates to the single one of other species, one of them being the specimen used by Wachsmuth and Springer in describing their species, D. excavatus, which must now go into synonymy. The abnormal specimen from which the description was made was also exceptional in having keellike ridges somewhat similar to those of D. epinosus, from a specimen of which the basal cavity was drawn, that of the type being filled with matrix; so the figure as to this part is incorrect. Both specimens were poor, neither of them typical of the species to which it belonged. Miller and Gurley anticipated the publication with their two fine species, which happily obviates any confusion now, although some authors persisted in using the name D. excavatus, notwithstanding I had privately informed them that the species could not stand.

The shallow, broader concavity outside of the basal pit usually involves part of the axillary primibrach. The radial series from the edge of the pit slope gradually from their margin to the middle, forming a broad, rounded, sometimes angular, median ridge; and exceptionally in well preserved specimens the two primibrachs are raised into a broad conical node radiately grooved, or rarely into a keellike ridge as in *D. spinosus*. The surface is more or less sharply sculptured with numerous somewhat sinuous lines and wrinkles. There is considerable variation in this ornament, but it is wholly subordinate to the dominant characters of the species.

The tegmen is broadly convex, with a slight overhang at the margin, composed of more or less rugose plates, mostly large; but the interambulacral areas are occupied by transverse belts of narrow, elongate, triangular plates, between the lower, thin apexes of which the numerous pinnule openings emerge. Such long tegmen plates are a feature of all those species having several openings to the interray, and those with the larger number have a slightly overhanging roof. The relation of the pores, as already discussed, to the fixed pinnules which lead to them is well shown in the lateral views given on plate 7, figures 2, 4, 5.

D. grandis is a good illustration of the small importance to be attached to minor variations occurring in a form having a few strong and dominant specific characters; modifications of surface structure, for example, which might be utilized toward the differentiation of forms less definitely fixed, may here be wholly disregarded.

In size D. grandis is typically a very large species, maximum specimens attaining 35 mm. in height and 60 mm. in width, the average ratio of height to width being about as 1 to 1.6. But few approach a minimum of 20 mm. wide; a specimen of that size, abnormal, like the three above mentioned, in having a single iBr in the second range of some interrays, was mistaken by Miller and Gurley for D. marshi, and figured as such in their endeavor to improve upon Lyon's original description of the species. Misled by their misidentification, Rowley figured a specimen of this species in 1903 as D. marshi, but afterwards in 1906 decided to make a new species of it, namely, D. fossatus. His D. excavatus, var. incarinatus was separated because lacking a keeled radial ridge, and having a high tegmen, both being individual variations observable in a large series of specimens.

As early as 1849 this species was recognized by the pioneer western geologist and paleontologist, Gerard Troost, of Tennessee, who prepared an elaborate description and good figure of it under the name Cacabocrinites sculptus, announced by Prof. Louis Agassiz at the meeting of the American Association for the Advancement of Science for that year. This would have been the type of the genus but for the long delay in publication, by which Troost's priority as to this and many other well-known crinoids was lost.¹²

Miller and Gurley ¹³ give the horizon of *D. grandis* as Hamilton; but it is well known to all the collectors that the specimens of this species occur only in the Onondaga formation (usually labeled "Upper Helderberg"), below the hydraulic beds which constitute the recognized boundary in that locality. Mr. Greene in a letter to me of November 9, 1903, in reply to an inquiry touching the horizon of this and other species, informed me that he furnished Mr. Gurley the types of *D. grandis* and *D. spinosus*, and that both came from the "Upper Helderburg" at Louisville.

Horizon and locality.—Onondaga (Jeffersonville) limestone: Louisville, Kentucky, and vicinity.

DOLATOCRINUS SPINOSUS Miller and Gurley.

Plate 8, figs. 1-7; plate 10, fig. 1.

Dolatocrinus spinosus MILLER and GURLEY, Bull. 4, Ill. St. Mus., 1894, p. 8, pl. 1, fig. 4.—Rowley in Greene, 1903, p. 164, pl. 48, fig. 4.

Dolatocrinus curriei Rowley in Greene, 1903, p. 143, pl. 42, figs. 1-6.

This is one of the two leading species of the Onondaga beds at Louisville (although erroneously stated by its authors to be from the Hamilton). Miller and Gurley had a poor specimen, in which the surface sculpture was not preserved; but there was enough other-

See the account of this by Miss Wood, Bull. 64, U. S. National Museum, 1909, pp. 1-7.
 Bull. 4, p. 16.

wise to enable them to give a recognizable definition from which the species can be identified beyond any question. With about 50 specimens in my own collection for comparison, many of them very well preserved, the essential characters are clearly evident, as the new figures show.

As in the case of *D. grandis*, this is typically a large-sized species, 33 of the specimens being from 40 to 55 mm. in width, and 8 from 30 mm. down to a minimum of 15 mm. wide, the remainder being intermediate; the average height to width of the calyx is about 1: 1.65, and the height of the dorsal cup is usually more than half that of the calyx. Below the arm openings the calyx is depressed hemispheroidal, shallowly concave below, with column facet abruptly sunk, involving only the basals. The first interbrachial is a very large plate, 11-sided from the abutting of IIIBr due to the second bifurcation in the ray, giving 4 arms to the ray contrasted with the 2 in *D. grandis*; this plate is truncate above, supporting one large median second interbrachial, as usual in the genus, with the sole exception of *D. grandis*.

The surface ornament in general consists of fine radiating lines, producing combinations which take the form of included triangles, and sometimes crossed by others, causing a pitted appearance. The one conspicuous feature of the sculpture is a strong, keel-like ridge along the radial series, which however is always confined to the radials and primibrachs. This keeled protuberance varies in shape from a fairly strong rounded ridge to a very high, knifelike edge; but it never passes along the ray beyond the primibrachs.

The tegmen is moderately convex, sometimes more or less conical, broadly but not deeply lobed, and surmounted with strong spines above the ambulacral series and around the base of the tube. Pinnule openings four to the interray, the outer pair often broken away; and two, sometimes four, in the spaces within the ray; not so prominent as in *D. grandis*.

With such a large number of specimens in hand it is interesting to see how true to type they run. Out of 21 specimens having the tegmen intact, all except 3 have strong spines, and in these, although rather weak, the projections are nevertheless pointed spines. Of the 20 specimens in which the arms can be counted, the only departure from the normal 20 arms is seen in two specimens which lack an arm in two rays and in one ray, respectively.

Rowley's D. curriei is merely a typical specimen with the surface ornament preserved, which was lacking in the type.

Horizon and locality.—Onondaga (Jeffersonville) limestone: Louisville, Kentucky, and vicinity.

DOLATOCRINUS LAMELLOSUS Hall.

Cacabocrinus lamellosus HALL, Fifteenth Report, New York State Cab., 1862, p. 141.

This species has never been figured. What purports to be the type specimen in the American Museum of Natural History has only the dorsal parts preserved. It is a very large, crushed specimen about 55 mm. wide, with plate arrangement similar to that of D. spinosus. Although recorded by Hall as from western New York, without definite locality, this specimen, lying with some others from Louisville, strongly resembles them in appearance, and may be from the same locality. It may be identical with spinosus, and if so would take priority; but inasmuch as we know nothing of the tegmen, in which one of the important characters of that species occurs, the evidence is insufficient for a decision, and the younger name will have to stand, leaving the other one in doubt.

Horizon and locality.—? Hamilton shales of western New York.

DOLATOCRINUS INSUETUS Rowley.

Plate 8, fig. 8.

Dolatocrinus insuetus Rowley in Greene, vol. 2, 1906, p. 8, pl. 3, fig. 4. Dolatocrinus excavatus Rowley in Greene, 1903, p. 191, pl. 57, fig. 17.

Of the type of *D. spinosus*, but the keellike ridges traverse the entire radial series to the arm bases; and the tegmen, instead of strong spines, has usually only a few sharp tubercles. It is a good species, definitely marked, and I am glad to be able to confirm Professor Rowley's description by four fine specimens in which the correlation of the above noted characters is fairly constant.

Horizon and locality.—Onondaga (Jeffersonville) limestone: Louisville, Kentucky, and vicinity.

DOLATOCRINUS MAJOR Wachsmuth and Springer.

Plate 9, figs. 1, 2.

Dolatocrinus major WAGHSMUTH and SPRINGER, North American Crinoidea Camerata, 1897, p. 312, pl. 25, fig. 5.

This is another very striking species of the Onondaga, hitherto but little known, which is marked by some decisive characters. When described, the type was the only specimen known, and that one lacked the tegmen; but the subsequent acquisition of eight additional specimens has confirmed the diagnosis, while also showing a considerable range of variation within a strong specific type. The position and arrangement of the pinnule openings resemble those of D. grandis, reduced in number owing to the doubling of the arms, and there is also a sporadic appearance of 2 plates in the second interbrachial range; but otherwise there is no close relation to that species.

This form is usually of very large size, flattened specimens ranging from 50 to 75 mm. in width, but even a small one of only 40 mm.

diameter shows no material departure from the typical characters. The perfectly smooth surface, without sculpturing or any other marking except a small node or spine on the first (sometimes second) primibrach, which exceptionally also develops into a keellike ridge as in *D. spinosus*; and the peculiar cordate shape of the first interbrachial, with its usually wide distal margin for the support of the very large second plate (exceptionally angular and supporting two plates as in *D. grandis*); are characters which readily differentiate the species from all others.

A somewhat crushed calyx with part of the smooth tegmen intact shows the arrangement of the pinnule openings, four or six to each interspace between the 20 arms; it shows that the general form of the calyx was broad and low, somewhat constricted below the arms, with a truncate or broadly curving base containing a relatively small basal pit. In this the basals are seen to be more or less obsolete, encroached upon and much of their substance resorbed and replaced by the large stem-lumen, analogous to the case of *Hadrocrinus*. In three specimens the nodes on the radials have enlarged into high, keeled ridges, and in one they are produced into sharp spines—variations which are immaterial in view of the strong dominant characters of the species.

Horizon and locality.—Onondaga (Jeffersonville) limestone: Louisville, Kentucky, and vicinity.

DOLATOCRINUS EXSTANS, new species.

Plate 10, figs. 8, 9.

In this species we have a complete departure from the usual habitus of the genus in the presence of a strongly protuberant base, instead of the usual concave or flat condition. It is proposed upon the evidence of eight specimens, which were found by the late George K. Greene, in the Onondaga formation at the Falls of the Ohio, near Louisville. They were obtained during a season of low water, all from the same layer and rather near together, the form being entirely new in the experience of the collectors of that locality. The specimens are all more or less crushed and imperfect, but indicate a calvx of large size—probably 65 or 70 mm. in diameter—and having at least 6 arms to the ray, or 30 (perhaps more) in all. The plates of the dorsal cup have usually a conical central elevation. Correlated with the protuberant base is the presence in the tegmen of long, sharp spines, some of them 25 mm. in length. The interbrachials are of the typical form for the genus, with an occasional irregularity the large plate of the first range being sometimes 11-sided on account of contact with tertibrachs.

Horizon and locality.—Onondaga (Jeffersonville) limestone: Louisville, Kentucky, and vicinity.

DOLATOCRINUS MULTIBRACHIATUS Rowley.

Plate 9, figs. 3, 4.

Dolatocrinus multibrachiatus Rowley in Greene, 1903, p. 141, pl. 41, fig. 7.

Founded on a specimen having a calyx similar to that of *D. spinosus*, but with an additional bifurcation in the rays, giving 40 arms. I am able to confirm it by seven specimens of similar form having one or more rays preserved, all of which have six or eight arms to the ray. I have figured one of these, which is badly crushed, but shows the surface characters better than the type, and another clearly showing the numerous arms.

Horizon and locality.—Onondaga (Jeffersonville) limestone: Louisville, Kentucky, and vicinity.

HAMILTON SPECIES.

[Valid species in italics; synonyms in roman.]

(· • • • • • • • • • • • • • • • • • •
With 10 arms.
Medium to large size.
Calyx wide and low; ornament with sharp radiating striae. D. liratus. —var. multilira.
Calyx higher, ornament with interrupted lines or pustules. D. glyptus. —var. intermedius.
Calvx, low, basin-shaped, with small basal pit; ornament
variable, strong nodes or fine striae predominating D. asperatus. —marshi, var. hamiltonensis.
Small, subglobose to oblate spheroidal.
Strong central nodes, with coarse radiating striae; ridges forming rim around basal pit.
Calyx rather high
Calyx broader, ornament obscure
With 10 to 20 arms.
Small to medium size.
Calvx decanter-shaped, truncate and broadly concave be-
low, basal cavity bordered by prominent pentagonal rim.
Radial ridges and nodes inconspicuous; radiating striae sharp, both fine and coarse.
Tegmen high, conical, smooth; pinnule openings con-
spicuous. Tegmen not lobed. Arms about 15 D. stellifer.
—hammelli.
laguncula.
—aplatus.
discimilaris.
-neglectus.
Tegmen lobed. Arms 15

With 10 to 20 arms—Continued. Small to medium size—Continued. Calyx large, subcylindrical; base broadly concave, without pentagonal rim. All plates of cup tumid, rugose, radiately furrowed or wrinkled, sloping from margin to cen-Tegmen subconical, smooth. Pinnule openings conspicuous. Tegmen somewhat lobed. Arms 15 to 20..... D. amplus. —vasculum. -peculiaris. -lyoni Wachsmuth and Springer. ---pernodosus. -wachsmuthi. Tegmen less lobed. Wrinkles on cup plates rather irregular. Arms 20, in nearly continuous ring..... D. costatus. Calyx of medium size, more or less rotund above; base truncate, with narrow pit. Radiating striae strong, those on iBr and radials forming a conspicuous star around the basal pit. Tegmen not lobed; low, convex, rugose. Pinnule openings conspicuous. Arms normally 15..... D. asterias. Radiating striae sharp, forming triangles, but not sharply defined star; ridges not prominent. Tegmen rugose, broadly lobed. Pinnule openings obscure. Arms 20...... D. incisus, new species. Calyx small to medium size; bowl-shaped, hemisperoidal, not constricted below arms; sides curving evenly upward from narrow base. Tegmen low. Pinnule openings not conspicuous. Arms 15 to 20. Medium size; strong nodes radiately arranged, or interrupted ridges on plates, without fine striae...... D. venustus. -aureatus. -lyoni Miller and Gurley. —corbuliferus. Fine strike forming triangles. Tegmen strongly lobed, and more or less spinous.... D. bellarugosus. -coeletus. ---arrosus. -var. cognatus. —depressus. Small; radial ridges high and sharp, with fine striae. Arms mostly about 20..... D. exornatus. -dispar. Insufficiently known. Arms 15..... D. canadensis. Calyx large to medium size. Bursiform, constricted below the arms; base truncate, broad, flat, or shallow concave; tegmen more or less lobed; pinnule openings often inconspicuous, usually 2 to each arm base, may be 4 to the interray.

With 10 to 20 arms-Continued. Calyx large to medium size, etc.—Continued. Ridges on radial series more or less continuous; central nodes on RR and iBr not prominent, or absent. Surface ornament chiefly by rows or clusters of pustules or wrinkles more or less radiately arranged. Very large and massive; surface coarsely wrinkled..... D. magnificus. Less massive; calyx broad; radial ridges low, rounded, not enlarging at the centers; ornament by sinuous radiating lines. Tegmen low and broadly lobed..... D. corporosus. var. decoratus. -welleri. Surface ornament by distinct radiating striae tending to form geometrical figures, more or less combined with scattered pustules. Calyx broad and low. Tegmen low, smooth, obscurely lobed, plates indistinct D. indianensis. -preciosus. Tegmen rugose, distinctly lobed, plates well defined, with small nodes or pustules.... D. greenei. -corporosus, var. concinnus. Calyx high. Tegmen ventricose or high conical, strongly lobed, more or less covered with small -sacculus. --- salebrosus. -charlestownensis. -cistula. -asper. -eicosidactylus. -springeri. Ridges on radial series more or less discontinuous; nodes on radials and iBr prominent. Surface ornament by radiating striae, usually dis-. tinct, forming geometrical figures. Tegmen ventricose, lobed, with more or less small scattered spines or sharp nodes..... D, bellulus. -basiliens. -noduliferus. Tegmen flatter, but little lobed, and without nodes or spines..... D. nodosus. —tuberculatus. -multinodosus. -elegantulus. Tegmen lobed, with strong nail-head spines.... D. fungiferus.

As of the 62 species and varieties described from the Hamilton over 60 per cent are considered to be synonyms, it will be convenient to treat them by groups, following the arrangement in the foregoing key.

Form 1. LIRATUS group.

Ten-armed; medium to large size.

DOLATOCRINUS LIRATUS Hall.

Plate 10, figs. 10, 11.

Cacabocrinus liratus HALL, Fifteenth Rep. New York State Cab., 1862, p. 139.

Dolatocrinus liratus Wachsmuth and Springer, N. A. Crin. Cam., 1897, p. 319, pl. 26, fig. 3.

Dolatocrinus liratus, var. multilira Hall, Fifteenth Rep. New York State Cab., 1862, p. 139.

Horizon and locality.—Hamilton shales: near Bellona, New York.

DOLATOCRINUS GLYPTUS Hall.

Cacabocrinus glyptus Hall, Fifteenth Rep. New York State Cab., 1862, p. 140. Dolatocrinus glyptus Wachsmuth and Springer, N. A. Crin. Cam., 1897, p. 317, pl. 26, figs. 2a, b.

Dolatocrinus glyptus, var. intermedius Hall, Fifteenth Rep. New York State Cab., p. 141.

Ten-armed species of medium to large size, and strongly ornamented, the former with sharp radiating striae and the latter with interrupted lines or pustules; in the former the calyx is wider and lower than in the latter. The two species and varieties were not illustrated by Hall, but figures were given along with the redescription of them by Wachsmuth and Springer, and I have figured two typical specimens of liratus. Except for the difference in number of primibrachs, it would be difficult to distinguish this species from Stereocrinus triangulatus of the Michigan area. I have not the material for a critical comparison of these forms, which will be done later on by the New York State museum, and pending that I list the varieties as synonyms under the respective species, as was done by Wachsmuth and Springer. An extremely abnormal specimen of this type in the museum at Albany shows a single branching arm, which is evidently sporadic.

Horizon and locality.—Hamilton shale: Western New York.

DOLATOCRINUS ASPERATUS Miller and Gurley.

Plate 6, figs. 5-12.

Dolatocrinus ornatus, var. asperatus MILLER and GURLEY, Bull. 4, Ill. St. Mus., 1894, p. 15, pl. 3, figs. 4-6.

D. marshi, var. hamiltonensis Wachsmuth and Springer, N. A. Crin. Cam., 1897, p. 314, pl. 25, figs. 2a, b.

As a hold-over from the Onondaga, this form became subject to some extreme variations in surface characters, such as have been relied upon with confidence by authors in their descriptions, and some of which I am attempting to utilize further on in this paper to assist in holding a number of described species which probably

should all be dumped into synonymy. The earlier species is exceedingly well marked by its general curvature, small basal pit, low and strongly lobed tegmen covered with small tubercles, projecting lip above the interrays, and uniformly 10 arms. All these features the Hamilton forms have, so that one is struck by the resemblance at the first glance, despite the difference in size, and can not help feeling that this is a good example of the breaking up of specific lines incident to the approaching extinction of the group. The specimens are mostly of considerably larger size than those of the Onondaga species, and along with this the great variability in surface markings may be taken as a character upon which to call Miller and Gurley's variety a species. There are six good specimens besides the type, and they include ornament by fine striate lines, wrinkles, tubercles, or pits, with median radial ridge low and rounded, or concentrating in strong separate nodes on the radials and primary brachials, or extending keel-like and sharp to the arms. The last form covers Wachsmuth and Springer's D. marshi, var. hamiltonensis, which in the leading characters resembles this species more than the one with which it was associated. In addition to Miller and Gurley's type, 1 have figured four specimens of this form as an object lesson upon surface ornament in this genus.

Horizon and locality.—Hamilton (Sellersburg) limestone: Charlestown, Indiana, and vicinity.

Form 2. BULBACEUS group.

Ten-armed; small, subglobose to oblate spheroidal.

DOLATOCRINUS BULBACEUS Miller and Gurley.

Plate 11, figs. 1-3.

Dolatocrinus bulbaceus Miller and Gurley, Bull. 4, Ill. St. Mus., 1894, p. 22, pl. 2, figs. 13-15.

Dolatocrinus pulchellus MILLER and GURLEY, Bull. 6, p. 55, pl. 5, figs. 13-15.—Rowley in Greene, 1903, p. 109, pl. 33, figs. 16-18.

Dolatocrinus aspratilis MILLER and GURLEY, Bull. 9, 1896, p. 49, pl. 3, figs. 16-18. Dolatocrinus subaculeatus Whiteaves, Contr. Canad. Pal., vol. 1, 1898, p. 369, pl. 6, figs. 6, 6a.

A small, subglobose form with subpentagonal outline, well described and figured by Miller and Curley under the several specific names above cited. Typically it is marked by sharp central nodes on first interbrachials and radials, with a strong ridge connecting the latter and forming the prominent rim of a broad pentagonal basal pit; the sculpturing may vary from sharp to obscure, and the general form from subglobose to oblate spheroidal. Arms 10. A well-defined type and abundant.

Out of 45 specimens in my collection, all of which in other respects are strictly conformable to the type, a single one sporadically has an extra arm in one ray, giving the 11 acms on which Miller and Gurley's synonym aspratilis was formed; along with the types in the Gurley collection are about 20 normal specimens of bulbaceus; and these two exceptional specimens are in every other character perfect examples of the species thus so numerously found. Two other of my specimens have an extra plate in the second interbrachial range in one area, a variation on which mainly D. argutus was described. The figured type of D. bulbaceus is incorrectly drawn: it is an abnormal specimen, having the posterior interradius irregular, with two plates in the second range like the two specimens in my collection above mentioned; it is of maximum size among specimens of this type, but with it in the Gurley collection as cotypes not figured are two smaller specimens of about average size—namely, 12 mm. high by 15 mm. wide. D. aspratilis is almost a counterpart of these two specimens; and I have figured a normal specimen from my collection.

This was a wide-ranging form, and occurs in the Hamilton of Thedford, Ontario, as D. subaculeatus of Whiteaves, which can not be distinguished from an average specimen of bulbaceus.

The authors say that D. bulbaceus has no "ovarian pores," and on their supposed absence chiefly proposed their second species, D. pulchellus; but the pinnule openings are present in the three types and in all well-preserved specimens; they are always close under the arm base, not in the open space between, one to each arm on the outside of the dichotom and rarely visible on the inside, as the arm usually becomes free after the first secondibrach. They also note for pulchellus a "difference in general form and surface ornament." The type of D. pulchellus is a relatively lower and wider form than that of bulbaceus, the ratio of height to width in the types of the several species being: bulbaceus, 1:1.25; aspratilis, 1:1.2; pulchellus, 1:1.5. A few specimens like the latter may be selected out of the general lot, but there would be every gradation between them and the others, all conforming strictly to the type in other respects. Relative sharpness or obscurity of the ornament proves nothing, all being of the same characteristic type, and the difference in prominence of sculpturing not being correlated with other characters. Professor Rowley, when figuring a specimen under the name pulchellus, says he has little doubt "that D. bulbaceus, D. pulchellus, D. argutus, and D. aspratilis are one and the same species."

Horizon and locality.—Hamilton limestone: Louisville, Kentucky and vicinity; Thedford, Ontario.

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DOLATOCRINUS ARGUTUS Miller and Gurley.

Plate 11, figs. 4, 5.

Dolatocrinus argutus MILLER and GURLEY, Bull. 8, Ill. St. Mus., 1896, p. 41, pl. 3, figs. 4-6.

I have listed this species separately, although perhaps only a variant of the preceding. It has a little different aspect, being less globular and wider in proportion to height than typical specimens, and these characters being correlated with a shallower basal cavity, lower tegmen, less angular contour, and a decidedly smoother surface.

Horizon and locality.—Hamilton (Sellersburg) limestone: Charlestown, Indiana, and vicinity.

From 3. STELLIFER group.

With about 15 arms. Decanter-shaped, with broadly concave base and smooth tegmen.

DOLATOCRIUNS STELLIFER Miller and Gurley.

Plate 11, figs. 6-8.

Dolatocrinus stellifer MILLER and GURLEY, Bull. 4, Ill. St. Mus., 1894, p. 20, pl. 2, figs. 10-12.

Dolatocrinus hammelli MILLER and GURLEY, Bull. 6, 1895, p. 52, pl. 5, figs. 4-6.

Dolatocrinus aplatus MILLER and GURLEY, Bull. 8, 1896, p. 48, pl. 3, figs. 16-18;

Bull. 9, pl. 3, figs. 13-15.—Rowley in Greene, 1903, p. 136, pl. 39, figs. 6-8.

Dolatocrinus laguncula MILLER and GURLEY, Bull. 9, 1896, p. 51, pl. 3, figs. 19-21.

Dolatocrinus dissimilaris MILLER and GURLEY, Bull. 9, 1896, p. 54, pl. 3, figs. 25-27.

Dolatocrinus neglectus MILLER and GURLEY, Bull. 12, 1897, p. 37, pl. 2, figs. 27-29.

A group of synonyms representing a single well-defined form, of a thoroughly distinct facies, readily recognized from fragmentary specimens, and differing from one another only in immaterial and inconstant details.

Calyx decanter-shaped, with dorsal cup low, deeply and broadly concave at the base, the concavity extending to the middle of the first interbrachial; the tegmen rising in a high neck, which passes gradually into the subcentral anal tube. Measuring to the level where the tube begins to be defined, the proportionate height to width is about 1:1.6 in the types of all the species. Radial ridges are small and inconspicuous, and on each side of them, connecting with the interbrachials, the plates are closely, deeply, and radiately striated, forming geometrical figures. This sculpturing varies from coarse (single) to fine (doubled) striae, without any relation to other characters, the latter style being rather the most common; in the four type specimens of *D. aplatus* two have fine striae and two coarse. A very distinct ridge connecting the centers of the radials forms a

pentagonal figure within the general basal concavity that is a conspicuous feature of the ornamentation.

The tegmen is rather evenly convex to the base of the tube, and its perfectly smooth and even surface, combined with the decanter shape, produces a habitus that is highly distinctive. This characteristic appearance is enhanced by the prominence of the pinnule openings, which are large curved slits, conspicuously placed in the open spaces between the arms, one at each side of every arm base, and frequently two more in the interrays. The habitus thus indicated is uniform among the type specimens of the several species and also throughout a series of good specimens additional to the types.

The distinction chiefly relied upon by the authors in the descripof these species is the number of arms, as to the sufficiency of which they are quite frank. Under D. laguncula 14 they say:

In surface ornamentation and general form it resembles D. hammelli, but that species has 16 arm openings, while this has only 14, which will readily distinguish the species.

And under D. dissimilaris 15:

In general form it resembles D. aplatus, but that species has 15 arms, while this has 13, so the arm formula alone will distinguish them.

I have in hand for the study of this form the 7 figured types and 5 cotypes labeled with them, 9 other specimens from the Gurley collection, and 16 from my own, making 37 in all. The range of variation in arms among them is from 11 to 17 in number, distributed as follows: With 11 arms, 1; with 13 arms, 7; with 14 arms, 5; with 15 arms, 20; with 16 arms, 3; with 17 arms, 1.

Thus more than half the specimens have 15 arms, and 95 per cent of them have that number within one or two more or less; which indicates that 15 is the normal number—3 arms to the ray, as it is almost without exception in the closely related *D. triadactylus* from Michigan—the small deviations from the normal being due to sporadic increase or diminution irregularly in one or two rays.

I have also examined the specimens with reference to the so-called "ovarian apertures," which are so strongly featured in the descriptions. As stated above, there are always a pair of them at each arm base in this form, and frequently an additional pair between the main ray divisions; but these differences are not uniform for the species as described. For example, in D. hammelli, the "16-armed species," the description says there are two apertures in each interradial area and two separating the arms in each of the five rays, giving "20 of these apertures;" yet one of the specimens selected by the authors as a cotype, and also a 16-armed specimen of my own, have four apertures between the rays, or about 40 in all. D. aplatus, the

"15-armed species," is described with "four ovarian slits between each (sic) radial series, and two between each (sic) of the ambulacral openings, which gives to this species 40 ovarian apertures;" but among the cotypes selected by the authors are three specimens with only two openings either between the rays or their divisions, and among 16 other specimens with 15 arms, 11 have two and four openings, and four have only two to each interval. The same thing applies to D. laguncula, the "14-armed species," which among five specimens has two with two and four openings, and three with only two. So if the species were to be arranged according to this character it would throw together forms with 11, 13, 14, 15, and 16 arms in one species, and forms with 13, 14, 15, 16, and 17 arms in another. As to these openings, the number observed depends somewhat upon the preservation of the specimen and the level at which the arms are detached; two of the openings in the interrays are well exposed in the median part, and always very plain, but the other two often lie close under the arm bases, and if the first pair of arm brachials are broken off these openings may not be seen. It is probable that there were normally four openings to the interrays, two of which may not always be observable for the reason stated.

The species is of medium size, ranging from about 12 to 20 mm. height of calyx to where the tube becomes defined, and 18 to 32 mm. in greatest width, the average height to width being about as 1:1.6.

Horizon and locality.—Hamilton (Sellersburg) limestone: Louisville, Kentucky, and vicinity.

DOLATOCRINUS TRIADACTYLUS Barris.

Plate 11, figs. 9, 10.

Dolatocrinus triadactylus Barris, Proc. Acad. Sci., Davenport, Iowa, vol. 4, 1884, p. 100, pl. 2, figs. 5-7.—Wachsmuth and Springer, N. A. Crin. Cam., 1897, p. 316, pl. 26, figs. 4a-d.

This form, from the Traverse beds of the Michigan Hamilton, belongs to the *stellifer* group, having the same excavate base, high, smooth tegmen, and the same type of sculpturing, including both fine and coarse striae, with a pentagonal rim bounding the basal cavity. It differs in having a strongly lobed tegmen. The 15 arms are constant in 23 out of 29 specimens, four others having 14, and two 16, all being from the same vicinity. It ranges in size from 7 to 23 mm. high, and 8 to 28 mm. wide. Especially among the smaller specimens, the calyx is relatively higher than in the Louisville form, so that the average height to width is here about 1:1.25.

Horizon and locality.—Hamilton (Traverse) shales: Alpena, Michigan.

Form 4. AMPLUS group.

Large, with broadly concave base; calyx plates turnid and rugose. Arms 15 to 20.

DOLATOCRINUS AMPLUS Miller and Gurley.

Plate 11, figs. 11-17; plate 12, figs. 14, 15.

Dolatocrinus amplus MILLER and GURLEY, Bull. 5, Ill. St. Mus., 1894, p. 45, pl. 4, figs. 6-8.—Rowley in Greene, 1903, p. 154, pl. 45, figs. 10-12.

Dolatocrinus vasculum MILLER and GURLEY, Bull. 6, 1895, p. 53, pl. 5, figs. 7-9. Dolatocrinus peculiaris MILLER and GURLEY, Bull. 9, 1896, p. 55, pl. 3, figs. 28-30. Dolatocrinus lyoni Wachsmuth and Springer, N. A. Crin. Cam., 1897, p. 314, pl. 25, figs. 6a-d.

Dolatocrinus pernodosus ROWLEY in Greene, 1903, p. 113, pl. 35, figs. 4-6. Dolatocrinus wachsmuthi Wood, Smithson. Misc. Coll., vol. 47, 1904, p. 77.

A sharply defined form, well described by the authors under *D. amplus*, with which they should have been content, without encumbering the literature with useless synonyms, based wholly on variation in the number of arms from 17 to 20. Wachsmuth and Springer described a typical specimen with 15 arms, which, according to Miller and Gurley's major criterion, should be a good species. Rowley added another with 17, because differently grouped; and from my material now in hand I could swell the list with a new species of 16 arms. Miss Wood contributed an additional name to replace the preoccupied species of Wachsmuth and Springer.

All these names and numbers stand for a single species, of a type so distinctive in plan of sculpturing that it may be recognized from a fragment containing a few plates of the dorsal cup. Instead of being marked by radial ridges, striae, or more or less prominent central nodes, all the plates are tumid or subspinous, radiately wrinkled or furrowed toward the margins, to which they slope from a a rounded or pointed center. The calvx is broadly truncate at about the level of the second primibrach, from which it curves inward to a broad concavity, involving the radials and part of the first interbrachials to about half the depth of the dorsal cup. It is subcylindrical from the level of the base up, and sometimes slightly constricted below the arms. Tegmen rather low, subconical, smooth, or finely pustulose; somewhat depressed or lobed in the interambulacral spaces. The pinnule openings are conspicuous in the form of long slits, two to each arm, and frequently four in the interrays. The two outside ones are located well under the edge of the arm base. and are often broken away.

The species is of large size, ranging from 20 to 35 mm. high and 30 to 50 mm. wide, the relative height to width averaging about 1:1.3.

In the broadly concave base, smooth tegmen, and prominent pinnule openings, this form is nearest to D. stellifer. Besides the

three types in the Gurley collection, I have eight good specimens, showing a range of from 15 to 20 arms, distributed as follows: Four with 15 arms, one with 17, one with 18, and five with 20. The characters otherwise are uniform in every essential particular. The pictures of surface ornament in Miller and Gurley's figures are not always to be depended on, and those given of this form show more difference among themselves than actually exists.

Horizon and locality.—Hamilton (Sellersburg) limestone: Charlestown, Indiana, and vicinity.

DOLATOCRINUS COSTATUS Wood.

Plate 12, figs. 1, 2, 3.

Dolatocrinus costatus Woop, Smithsonian Miscellaneous Collections, vol. 47, 1904, p. 70, pl. 16, figs, 6, 6a.

A good representative of the amplus group, from the Traverse beds of Michigan. In addition to the type figured by Miss Wood, I have three other specimens, one larger and two smaller; all have 20 arms, except one, which has an extra arm in one ray. So the number, toward which there was a strong tendency in the Louisville area, is here well established at 4 to the ray. There is a difference, not very clearly definable, in the style of sculpturing, due to the strong wrinkles on the plates of the cup, being in costatus less regularly radiating: the tegmen plates are more distinctly outlined, and the arms more nearly in a continuous ring. Pinnule openings are very conspicuous—two and four between arms and four or six between the rays. The specimens range in size about as those of the Louisville form—from 20 to 35 mm. high and 30 to 50 mm. wide.

Horizon and locality.—Hamilton (Traverse) shales: Alpena, Michigan.

Form 5. ASTERIAS group.

More or less rotund, with sides nearly vertical, truncate base and small basal pit.

DOLATOCRINUS ASTERIAS Wood.

Plate 12, figs. 4-7.

Dolatocrinus asterias Wood, Smithsonian Miscellaneous Collections, vol. 47, 1904, p. 71, pl. 16, figs. 1, 1a.

A medium-sized species, but small specimens are found occasionally. Calyx broadly basin shaped, more or less round above; sides nearly vertical or slightly expanding upward, and base truncate, with small, pentagonal-rimmed basal pit. Radiating striae strong and coarse, those from the first interbrachials crossing the radials and forming a conspicuous star surrounding the basal pit. Tegmen low convex, not lobed, covered with rugose plates. Pinnule openings conspicuous—two to each arm base and three or four in the interrays. Arms 15, their openings directed obliquely upward.

The basal star is a most striking and constant character, by which the species is readily recognized from the base alone. I have 25 specimens, in all of which it is perfectly distinct. Among 13 specimens in which the arm openings are observable, 10 have 15 arms, and one each 13, 14, and 16. In size the specimens range from 18 to 25 mm. high and 25 to 32 mm. wide, with a few somewhat larger or smaller. The average height to width is about 1:1.35, the smaller specimens being relatively higher and the larger ones lower.

Horizon and locality.—Hamilton group: Alpena and Partridge Point, Michigan.

DOLATOCRINUS INCISUS, new species.

Plate 12, figs. 8-13.

Similar to asterias, with which it is associated, but with more broadly concave base, and without the strongly modeled basal star, although a stellate arrangement of triangles is apparent in some specimens. Radiating striae sharply incised, wrinkled, forming triangular figures, either single or enclosing others. Tegmen broadly lobed. Pinnule openings obscure, probably two to each arm base. Arms 20.

The type of sculpturing is similar to that of Stereocrinus triangulatus, and unlike that of other Michigan forms of this genus. I have seven specimens of this form, ranging in size from 10 to 23 mm. high and 16 to 36 mm. wide; six of them show all the arm openings, which are 20 without exception.

Two specimens are figured, to show the extremes of fine and coarse sculpturing of the same type.

Horizon and locality.—Hamilton (Traverse) shales: Alpena, Michigan.

Form 6. VENUSTUS group.

Calyx small to medium size, bowl-shaped, hemispheroidal, not constricted below the arms; sides curving evenly to arms from narrow base, not concave. Tegmen low. Pinnule openings inconspicuous—2, or perhaps only 1, to each arm base. Arms, 15 to 20.

This general description includes a group of six species by Miller and Gurley and one by Rowley, among which I have attempted to separate three definable forms. All are typically small species, having about the same general proportions, and ranging from 8 to 20 mm. high and 12 to 28 mm. wide, the average height to width being 1:1.5. I have 22 specimens besides the types of Miller and Gurley, minus that of exornatus, which with two other of their types was lost before the Gurley collection was received by the University of Chicago, and for which we must rely upon the figures and descriptions. The arms in these 28 specimens vary from 12 to 20, distributed as follows: with 12 arms, 1; with 13 arms, 2; with 15 arms, 3; with 16 arms, 6; with 17 arms, 8; with 18 arms, 1; with 19 arms, 4; with 20 arms, 3.

These numbers bear no relation to any other characters, but it will be noted that 90 per cent of the specimens have 15 arms or more, and 60 per cent of them have 15 with only one or two arms more or less; so the type for this form is 15 arms, with a tendency to increase toward 20. The grouping of the species hereunder is more or less artificial, and the definitions are lacking in decisive characters, depending altogether upon the surface markings.

DOLATOCRINUS VENUSTUS Miller and Gurley.

Plate 13, figs. 1-5; plate 15, fig. 8.

Dolatocrinus venustus MILLER and GURLEY, Bull. 4, Ill. St. Mus., 1894, p. 23, pl. 2, figs. 16-18.—Rowley in Greene, 1903, p. 160, pl. 47, figs. 9, 10.

Dolatocrinus aureatus MILLER and GURLEY, Bull. 4, 1894, p. 24, pl. 3, figs. 1-3.

Dolatocrinus lyoni MILLER and GURLEY, Bull. 9, 1896, p. 44, pl. 3, figs. 4-6.

Dolatocrinus corbuliferus Rowley, 1903, p. 151, pl. 44, figs. 13-15.

Interrupted ridges, coarse nodes or pustules. These surface characters are not so well shown by the original figures as by the new drawings here given, made upon a photographic basis directly from the type. More faulty still are the authors' figures of venustus in not showing the general hemispheric contour, which is missed completely in their side view (fig. 17). The description agrees with the type as it is designated in the Gurley collection. Some other specimens among the duplicates labeled with this name are of doubtful authenticity, but I have four good specimens that can be assigned to this species, including a very characteristic one from Michigan. The species attains a larger size than the other two, ranging from 12 to 23 mm. high and 20 to 38 mm. wide.

Horizon and locality.—Hamilton (Sellersburg) limestone: Charlestown, Indiana and vicinity.

DOLATOCRINUS BELLARUGOSUS Miller and Gurley.

Plate 13, figs. 6-10.

Dolatocrinus bellarugosus MILLER and GURLEY, Bull. 8, Ill. St. Mus., 1896, p. 43, pl. 3, figs. 7-9.

Dolatocrinus coslatus MILLER and GURLEY, Bull. 8, Ill. St. Mus., 1896, p. 46, pl. 3, figs. 13-15.—Rowley in Greene, 1903, p. 165, pl. 48, figs. 10-12.

Dolatocrinus arrosus MILLER and GURLEY, Bull. 8, Ill. St. Mus., 1896, p. 52, pl. 3, figs. 22-24.—Rowley in Greene, 1903, p. 132, pl. 38, figs. 9, 10.

Dolatocrinus arrosus, var. cognatus Rowley in Greene, 1903, p. 137, pl. 39, figs 12-14.

Base rather wider than in the last species. Ornament by radiating striae with strong median ridges, more or less interrupted, and rather prominent central nodes. Tegmen sharply lobed and more or less spinous. The first three of Miller and Gurley's types are essentially duplicates, with a difference of one arm; the others differ slightly in proportions. I have 10 specimens besides, varying in

arms from 13 to 20, but 80 per cent of them from 15 to 17; and in size from 12 to 16 mm. high, and 17 to 22 mm. wide.

Horizon and locality.—Hamilton (Sellersburg) limestone: Charlestown, Indiana and vicinity.

DOLATOCRINUS EXORNATUS Miller and Gurley.

Plate 13, figs. 11, 12.

Dolatocrinus exornatus MILLER and GURLEY, Bull. 6, Ill. St. Mus., 1895, p. 54, pl. 5, figs. 8-10.

Dolatocrinus dispar MILLER and GURLEY, Bull. 9, 1896, p. 40, pl. 2, figs. 27-29.

Very small, with extremely fine striae; radial ridges high and sharp. The size is consistently small, being almost uniform at 8 mm. high and 12 mm. wide, and the tendency is to 20 arms. Out of seven specimens plus the types more than half have 19 to 20 arms, and all may have had about 20, as in this form the first bifurcation of the ray occurs very high up, and the next one is at the edge of the calyx, where the arms are becoming free, so that the second axillary is sometimes broken off and the full number of arms is not seen.

Comparison of the original description of this species with that of *D. aureatus* immediately following it, illustrates the method of the authors. The two descriptions are verbally identical as to the essential characters, the only difference being that *aureatus* has one less arm, and one more small plate in the third interbrachial range.

Horizon and locality.—Hamilton (Sellersburg) limestone: Charlestown, Indiana, and vicinity.

DOLATOCRINUS CANADENSIS Whiteaves.

Dolatocrinus canadensis Whiteaves, Contr. Canad. Paleont., vol. 1, 1887, p. 99, pl. 12, figs. 3, 3a.—Wachsmuth and Springer, N. A. Crin. Cam., 1897, p. 315, pl. 25, figs. 7a, b.

This species, described from the Hamilton of Thedford, Ontario, was founded upon a single small specimen probably somewhat eroded. It seems to be of the type of D. marshi, but with 15 arms instead of 10. A form somewhat similar to marshi has been noted from western New York, but the material is not available for comparison.

Horizon and locality.—Hamilton shales: Thedford, Ontario.

Form 7. MAGNIFICUS group.

Calyx large to medium size, occasionally small; oblate hemispheroidal, or depressed bursiform, constricted below the arms; base broadly truncate, flat, or shallow concave. Plates highly ornamented with ridges, striae, nodes, or pustules; radial series bearing nodes round or elongate, either separated, or connected by a narrow neck, or meeting at the sutures to form a continuous median ridge;

interbrachial plates marked by rows or clusters of pustules or wrinkles more or less radiately arranged, or by radiating striae crossing the sutures to adjoining plates and tending to form geometrical figures, which when the striae are fine may become intricate and form several included triangles; more or less prominent central nodes may be formed by coalescence of these radiate structures, or nodes may be wanting. Tegmen more or less lobed, ventricose or low convex, with plates smooth, granular, rugose, bearing small spinous tubercles, or rarely strong spines. Pinnule openings few and inconspicuous, often obscured by the rugose sculpture. Arms 15 to 20, exceptionally more or fewer.

The above description applies to the leading form of this genus in the Louisville area, for which no less than 22 species and 2 varieties have been named, 15 of the species by Miller and Gurley, and 7 species with 2 varieties by other authors. The wide bursiform calyx, constricted above and truncate below, with strong pustulose or striate ornamentation, imparts a facies which would well characterize a strong and variable species. It is represented by numerous individuals, among which may be found more or less difference in superficial characters, producing just such an assemblage of minor variations as is to be expected in a dominant species, flourishing abundantly under favorable conditions, at the acme of the group to which it belongs and on the eve of its extinction.

The instability of characters in this form is evidenced by the frequent occurrence of unsymmetrical conditions among the plates of the calyx: those of the radial series are often larger or smaller in one or two rays than in the others, as seen in Miller and Gurley's figure of D. greenei; or the interrays may be unequal, the posterior one frequently the largest; and all the principal plates—basals, radials, and interbrachials—are subject to considerable irregularities in size as between specimens otherwise identical. This unequal growth of plates which are usually pentamerously symmetrical in the crinoids produces a certain asymmetry in the contour rather frequently observed among the specimens of this form, by which the calyx will be higher or more ventricose in one part than another. Suppression of an entire ray occasionally occurs, as shown by Rowley's figure in Greene (pl. 47, fig. 2), and by specimens in my collection; also of one primibrach, as in Greene (pl. 57, figs. 16, 17, 18).

The numerous species which have been described under this form depend for the most part upon minor differences which are to be found in any vigorous and prolific species, notably those in the number and grouping of arms, upon which most of Miller and Gurley's

¹⁶ Bull. 4, pl. 31, fig. 10; also herein, pl. 14, fig. 7.

species are founded. The testing of the value of such characters in practice emphasizes the importance of ample material. I have before me the types of 15 of Miller and Gurley's species, and in addition 31 duplicates in the Gurley collection, and 76 good specimens of my own of which 62 show the full number of arms, thus making a total of 108 specimens of this form from which the number of arms can be tabulated, to which may be added the 9 types of Rowley. These range from 10 arms to 22, distributed as follows: With 10 arms, 2; with 11 arms, 1; with 13 arms, 2; with 14 arms, 4; with 15 arms, 9; with 16 arms, 21; with 17 arms, 16; with 18 arms, 25; with 19 arms, 16; with 20 arms, 18; with 21 arms, 1; with 22 arms, 2.

While this shows a wide range of disturbance in the arm development, it will be seen that the variation is chiefly within definite limits, about 90 per cent of the specimens having from 15 to 20 arms, and 50 per cent are within one or two of the higher number; so that normally this form has either three or four arms to the ray, the differences being due to the addition or failure of an arm irregularly in one or more rays.

These various numbers do not correlate with any other character: and with the actual specimens in hand every attempt to arrange species with reference to them is soon seen to be futile. The few groups which I have tried to define according to other criteria all embrace more or less of these variations in number of arms. As is to be expected, these groups shade into one another in a most perplexing way; they are the outcome of frequent shiftings of specimens from one to another, without achieving any result that seems to proclaim their identity by any positive or well-defined and palpable character. This lack of reliable definition shows the small taxonomic value of the variations noted, and it is probable that a far more drastic cutting down of species, even to the extent of throwing them all into one, would be the more logical course. In view of the considerable reduction of species which I have felt obliged to make, and in order to avoid too much dependence upon my unsupported judgment, I am publishing herewith new and accurate drawings made from a photographic basis of nearly all of Miller and Gurley's types, arranged in juxtaposition, so that the reader may judge for himself (pls. 13. 14. and 15). These type specimens are in some cases not so clear in point of distinctness of characters as could now be selected for illustration; but I have not undertaken to prepare other figures, beyond one or two to give a better view of the general type, to illustrate variations, and to show that the purse-like contour which is the striking character of this form is not due to age, since it appears as distinctly in the smaller specimens as in the most mature (pl. 16).

DOLATOCRINUS MAGNIFICUS Miller and Gurley.

Dolatocrinus magnificus MILLER and GURLEY, Bull. 4, Ill. St. Mus., 1894, p. 1, pl. 1, figs. 1-3.

This was Miller and Gurley's first species of this form, and while its pustulose and wrinkled sculpturing is simulated to some extent in later species, this one may well stand apart on the ground of its size, coarse ornament, and massive form. The type is about 35 mm. high and 65 mm. wide. There are among my material several specimens more or less imperfect, all of approximately the same dimensions, and there is a very distinct gap in size between these and specimens of what is regarded as the next largest species—corporosus. The two forms are quite similar, but magnificus, by reason of some flattening of the interrays, takes on a somewhat pentagonal outline which other species do not possess. Half of these large specimens have 18 to 21 arms, while 90 per cent of the others have 15 arms or more, and of these, 50 per cent have 20, 21, and 22. The extra arms in these and in the type are clearly abnormal.

Horizon and locality.—Hamilton (Sellersburg) limestone: Louisville, Kentucky, and vicinity.

DOLATOCRINUS CORPOROSUS Miller and Gurley.

Plate 14, figs. 1, 2; plate 16, figs 1, 2.

Dolatocrinus corporosus MILLER and GURLEY, Bull. 6, Ill. St. Mus., 1895, p. 50, pl. 5, figs. 1-3.—Rowley in Greene, 1903, p. 157, pl. 47, figs. 1-3.

Dolatocrinus welleri Rowley in Greene, 1903, p. 143, pl. 41, fig. 14.

Dolatocrinus corporosus, var. decoratus Rowley, 1903, p. 149, pl. 43, figs. 7-9.

I have 12 specimens, besides two in the Gurley collection, which may fairly be assigned to this species, with its wide calyx, low tegmen, and coarse wrinkled ornamentation. It is typically a large species, ranging from 25 to 30 mm. height of calyx and 45 to 50 (exceptionally 75) mm. width, and it is approximately 20-armed. There are specimens with 16, 17, 18, 19, and 20 arms, and also exceptionally one with 10. Omitting the last, and counting the types, 50 per cent of the specimens have full 20 arms. I figure on plate 16 a maximum flattened specimen of this or one of the closely allied species, and also one which is a fine example of the typical bursiform calyx, but is a variant with only 10 arms.

Horizon and locality.—Hamilton (Sellersburg) limestone: Charlestown, Indiana, and vicinity.

DOLATOCRINUS INDIANENSIS Miller and Gurley.

Plate 14, figs. 3-6.

Dolatocrinus indianensis MILLER and GURLEY, Bull. 8, Ill. St. Mus., 1896, p. 40, pl. 3, figs. 1-3.

Dolatocrinus preciosus MILLER and GURLEY, Bull. 9, 1896, p. 40, pl. 2, figs. 27–29.— ROWLEY in Greene, 1903, p. 152, pl. 45, figs. 1–3, 4–6.

Both the type specimens to which the above names have been given are poorly preserved, and do not show the surface characters

very well. They are good examples of the bursiform calyx. But for the lower and smoother tegmen, which may both be incidental to fossilization, they could not be distinguished from the form included under *lineolatus*. A form strongly resembling these occurs in the Hamilton of Thedford, Ontario.

Horizon and locality.—Hamilton (Sellersburg), limestone: Clarkstown, Indiana, and vicinity.

DOLATOCRINUS GREENEI Miller and Gurley.

Plate 14, figs. 7-9; plate 16, fig. 3.

Dolatocrinus greenei Miller and Gurley, Bull. 4, Ill. St. Mus., 1894, p. 28, pl. 3, figs. 10-12.—Rowley in Greene, 1903, p. 158, pl. 47, figs. 4-6. 25. Dolatocrinus corporosus, var. concinnus Rowley in Greene, 1903, p. 148, pl. 44, figs. 4-6.

The more distinct radiating striae furnishes the slight ground for separating this from the corporosus form, and the distinction becomes decidedly hazy when the intermediate indianensis form is brought into connection with the others. All the specimens are large, with flattened tegmen, and the tendency is toward the maximum number of arms. The type of greenei is abnormal in having two rays larger than the others. Rowley's specimen is perhaps the most characteristic. Of five specimens in the Gurley collection labeled greenei, two have the specified number of 19 arms, two 18, and one 16; the last three labeled "small specimens," apparently by Mr. Miller himself.

Horizon and locality.—Hamilton (Sellersburg), limestone: Louisville, Kentucky, and vicinity.

DOLATOCRINUS LINEOLATUS Miller and Gurley.

Plate 13, figs. 13-18; plate 14, figs. 10, 11; plate 15, fig. 7; plate 16, fig. 8.

Dolatocrinus lineolatus Miller and Gurley, Bull. 4, Ill. St. Mus., 1894, p. 27, pl. 3, figs. 7-9.

Dolatocrinus sacculus MILLER and GURLEY, Bull. 7, Ill. St. Mus., 1896, p. 58, pl. 3, figs. 11, 12.

Dolatocrinus salebrosus MILLER and GURLEY, Bull. 7, p. 59, pl. 3, figs. 13-15.

Dolatocrinus charlestownensis MILLER and GURLEY, Bull. 8, 1896, p. 44, pl. 3, figs. 10-12.—Rowley in Greene, 1903, p. 153, pl. 45, figs. 7-9.

Dolatocrinus cistula MILLER and GURLEY, Bull. 9, 1896, p. 46, pl. 3, figs. 1-3.

Dolatocrinus asper MILLER and GURLEY, Bull. 9, 1896, p. 47, pl. 3, figs. 10-12.

Dolatocrinus eicosidactylus Wachsmuth and Springer, N. A. Crin. Cam., 1897, p. 319, pl. 26, figs. 5a-d.

Dolatocrinus springeri Rowley in Greene, 1903, p. 136, pl. 39. figs. 9-11.

The type included under the above name is the most abundant form in the present group. There are about 30 specimens in the collection which probably belong together, ranging in size from 15 to 35 mm. in height and 20 to 50 mm. in width. In 20 of these the arms can be counted, and about 75 per cent of them have from

15 to 18 arms; three have less than 15; one only 10; and the remainder have more, up to 20 and one abnormal 22; so this may be considered as typically a 15-armed form, as distinguished from the approximately 20 arms of corporosus. The generally higher and narrower calyx as compared with that of the corporosus type, and the more ventricose tegmen, with smoother plates rather obscurely defined and tending to develop small spinous nodes, are the characters to be noted. None of the Miller and Gurley types are good representatives of the mature stage of this form, and I have given a figure of the type of Wachsmuth and Springer's D. eicosidactylus which is much more characteristic; it attains even a larger size than this. I also figure a 10-armed specimen which belongs either here or under D. bellulus, as one chooses (pl. 16, fig. 5). Minimum stages of both species are shown by plate 16, figures 7, 8.

Horizon and locality.—Hamilton (Sellersburg) limestone: Charlestown, Indiana, and vicinity.

DOLATOCRINUS BELLULUS Miller and Gurley.

Plate 15, figs. 1-6; plate 16, figs. 4-7 (?9).

Dolatocrinus bellulus MILLER and GURLEY, Bull. 6, 1895, p. 57, pl. 5, figs. 16-18. Dolatocrinus basilicus MILLER and GURLEY, Bull. 9, 1896, p. 43, pl. 3, figs. 1-3. Dolatocrinus noduliferus Rowley in Greene, 1903, p. 140, pl. 41, figs. 1-3.

This and the next form are distinguished from those preceding by reason of having prominent nodes and discontinuous median ridges along the radial series, while they differ from each other mainly by the ventricose, lobed tegmen with small spinous tubercles in this species, as opposed to the low, non-spiniferous tegmen of the next following.

Horizon and locality.—Hamilton (Sellersburg) limestone: Charlestown, Indiana, and vicinity.

DOLATOCRINUS NODOSUS Miller and Gurley.

Plate 15, figs. 9-11.

Dolatocrinus nodosus MILLER and GURLEY, Bull. 7, Ill. St. Mus., 1895, p. 56, pl. 3, figs. 1-3.—Rowley in Greene, 1903, p. 163, pl. 48, figs. 1-3.

Dolatocrinus tuberculatus Wachsmuth and Springer, N. A. Crin. Cam., 1897, p. 324, pl. 25, fig. 3.

Dolatocrinus multinodosus Rowley in Greene, 1903, p. 147, pl. 44, figs. 1-3. Dolatocrinus elegantulus Rowley in Greene, 1903, p. 150, pl. 44, figs. 10-12.

Like the last, except for the flat tegmen, without nodes or spines, but sometimes with very small pustules, which may occur on any tegmen classed as smooth.

Horizon and locality.—Hamilton (Sellersburg) limestone: Charlestown, Indiana, and vicinity.

DOLATOCRINUS FUNGIFERUS Rowley.

Plate 15, figs. 12, 13.

Dolatocrinus funciferus Rowley in Greene, Contr. Indiana Paleontology, 1903, p. 134, pl. 39, figs. 1-3.

Of the type of *D. nodosus*, but distinguished from that species and all others of the genus by having the tegmen studded with short, thick, mushroom-shaped spines, which project like nail heads. It is a thoroughly well-marked species, not depending upon the evidence of a single type, for I have seven specimens in which the peculiar spines and correlated characters are constant; but the number of arms varies from 17 to 19. Rowley's figures give a very good picture of the species. The description gives the horizon as "Middle Devonian," which was Rowley's term for the Onondaga beds at Louisville, while he called the Hamilton "Upper Devonian." This was an oversight by Mr. Greene, as this form is typically Hamilton, and all my specimens, most of which were collected by him, are from above the hydraulic beds.

Horizon and locality.—Hamilton (Sellersburg) limestone: Louisville, Kentucky, and vicinity.

The final result of our review of the species and varieties of *Dolato-crinus* heretofore described, with the few new species added, may be shown by the following summary:

Species and varieties of Dolatocrinus.

	De- scribed before.	Syno- nyms.	Recog- nized.	New.	Total. valid.
Hamilton Onondaga	62 15	40 6	22 9	1 3	23 12
Total.	77	46	31	4	35

EXPLANATION OF PLATES.

Enlargement, if any, of the figures is indicated by the fraction at the end of the paragraph. Unless so noted, the figure is of natural size. All specimens figured, except as otherwise stated, are in the author's collection, now in the United States National Museum. No effort has been made to orient the specimens in the usual way with reference to the posterior side, which can not always be identified; they are posed rather with reference to the light in photographing.

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7

Fig. 1. Basal view of a typical specimen, showing varying forms of the reduced and modified first primibrach, extra plate in second range of posterior interradius, and the origin of the fixed pinnules as well as position of the sockets where they become free. ×3/2.

COMANTHOCRINUS INDIANENSIS (Miller and Gurley)

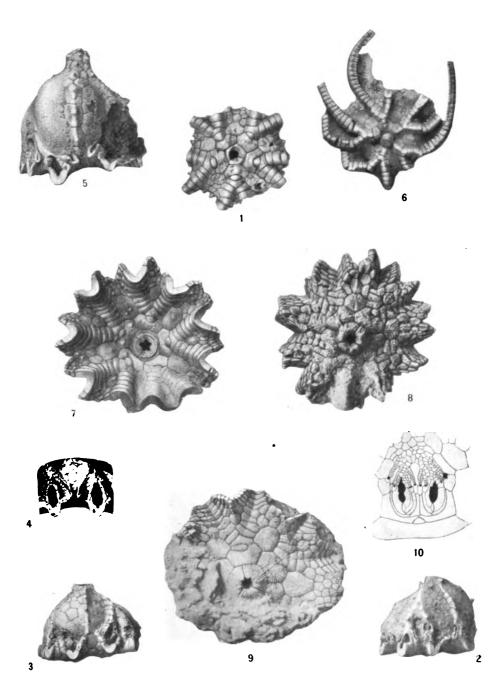
Clark County, Indiana.

- Profile view from left side of same specimen; showing the great preponderance of the tegmen in height, the bulging on the anal side, and course of pinnule-ambulances of the fixed pinnules. X3/2.
- 3. Posterior view of same; showing the strong median row of large plates leading from the narrow anal plate of the dorsal cup to the base of the sub-central tube. Openings for fixed pinnules are seen here also. ×3/2.
- Interradius of another specimen from the same locality, showing course of pinnule-ambulacra, now represented by open slits. ×3/2.
- 5. Posterior view of larger specimen from same locality, showing the strong anal series in the tegmen, base of anal tube, and the asymmetrical bulging of the tegmen not coinciding with the median row, but following the course of the gut. The specimen is much silicified, and the apperance of numerous small plates in the swollen part may be in part misleading. ×3/2.
- 6. Dorsal view of specimen with arms, from Canandaigua Lake, New York. It shows the heavy, uniserial arms, with two pinnule-sockets to the margin of each brachial beyond the fifth, and some of the very slender pinnules.

Hamilton: Louisville area, and New York.

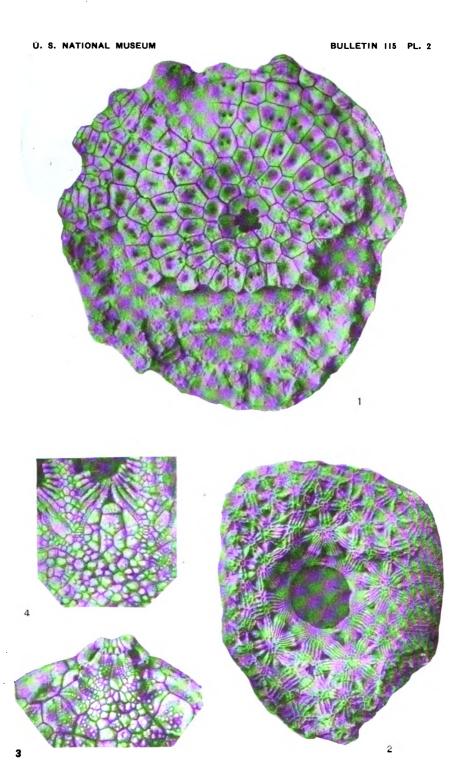
COMANTHOCRINUS PRISCUS, new species

- 7. Basal view of a free dorsal cup; showing the broadly concave base, large stem-lumen, deeply rounded rays, and V-shaped brachials, with the fixed pinnules leading from the secundibrachs; also the reduced first primibrach, and left posterior position of small basal. The posterior interradius in this specimen is slightly contracted by pressure.
- 8. Interior (ventral) surface of same specimen (the tegmen wanting), drawn with anal side up for better comparison of structures. It shows the position and relation of the fixed pinnules, and the exact plates upon which they originate (not all visible from the dorsal side); and the intricate complex of grooves and ridges passing from plate to plate, marking the lodgment of nerve cords.
- 9. Interior view of another specimen showing the same structures as the last with slight difference in detail. In this the small basal excepttionally is in the left anterior position. (See also text figs. 1 and 2.)
- 10. Sketch showing position of pinnule openings and course of ambulacra leading to them as seen in Marsipocrinus, represented by elongate slits in Comanthocrinus and Dolatocrinus; for comparison with figure
 - 4. From author's paper on Scyphocrinus, p. 42. Onondaga: Louisville, Kentucky.



COMANTHOCRINUS INDIANENSIS AND C. PRICUS.

FOR EXPLANATION OF PLATE SEE PAGE 80.



HADROCRINUS DISCUS, HIMEROCRINUS PLENISSIMUS, MARSIPOCRINUS STRIATUS, AND M. TENNESSEENSIS.

FOR EXPLANATION OF PLATE SEE PAGE 61.

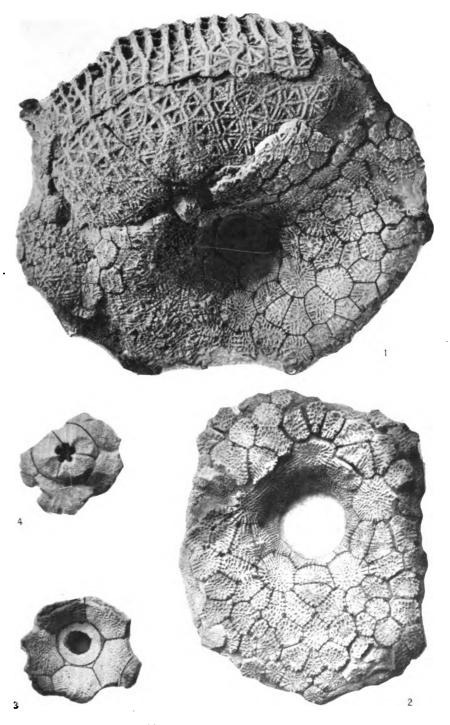
	PLATE 2.	Page.
	HADROCRINUS DISCUS Lyon	9
Fig. 1	1. Dorsal view of a specimen obtained since Lyon's time, showing all characters better than the type, namely, the shallow base, with minute notches at the corners of the radials indicating the remnants of atrophied basals; radials indented by the large stem-lumen, and marked by striae (not clearly reproduced in the printed figure) of the huge column facet which enveloped them; distribution of pits upon the calyx plates; and the beginnings of the heavy, biserial arms. Slightly under natural size. (See also text figs. 3 and 4.) Onondaga: Louisville, Kentucky.	
	HIMEROCRINUS PLENISSIMUS (Lyon)	12
2	 Unretouched photograph of a specimen minus the basals; to show the intense sculpturing by grooves and ridges which obscures the suture lines. Onondaga: Louisville, Kentucky. 	
	MARSIPOCRINUS STRIATUS Wachsmuth and Springer	5,24
3	3. Detail of part of tegmen of specimen from which the diagram, figure 10, Plate 1, was made, showing the ambulacra and the pinnule openings to which they lead. X2. Silurian: Tennessee.	
	MARSIPOCRINUS TENNESSEENSIS Roomer	5,24
4	4. Detail of part of tegmen with the pinnules themselves in position, both from the free brachials and from the interrays, corresponding to the openings in <i>Comanthocrinus</i> and <i>Dolatocrinus</i> . ×2. Silurian: Tennessee.	
	(Both the last from the author's paper on Scyphocrinus, Plate 9.)	
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HIMEROCRINUS PLENISSIMUS (Lyon)

- Fig. 1. Photographic view, but little retouched, of an almost complete calyx, showing the contour and surface sculpturing, from the deep basal cavity (in which the basals are present, though invisible in the shadow, without any columnals attached) to the high ridges at the margin leading directly to the free arms. The generic diagram (text fig. 5) was composed chiefly from this specimen, confirmed by several others as to some details. An overlapping transverse fracture interrupts the normal succession of plates in the upper part, but their arrangement is clear in the right lower sector, where many of the plates are slightly separated and the suture lines well marked. Here may be seen a good example of the modified axillary primibrach, as well as one of normal size and form. On account of the intricate sculpturing, no attempt has been made to outline the plates in the upper part of this figure, although with proper lighting they can be traced upon the specimen in the positions shown in the diagram. The specimen is oriented with the posterior interradius at the lower right, the small basal, here obscured by the shadow at the bottom of the cavity, being plainly visible in the left anterior position. The photograph is slightly under natural size, but owing to foreshortening the picture appears still more reduced. Measuring from base to margin, and allowing for the overlapping fracture, the spread of calvx is at least 15 cm. (See also text fig. 5.)
 - Photograph of dorsal side of a specimen minus base, showing a style of ornament formed chiefly by pits instead of grooves. Here the axil-
 - lary primibrach is of full size throughout. The second interbrachial range has an extra plate in two interrays, so the anal side can not certainly be identified.
 - 3. Dorsal (exterior) view of detached basals of a similar specimen, with part of column adhering in the cavity, and radials attached.
 - 4. Ventral (interior) view of detached base, with some radials attached, showing division of the basals, their deep inward projection, and the large pentapetalous axial opening.

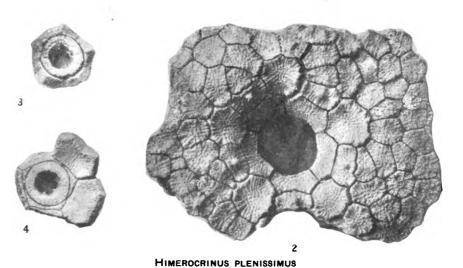
Onondaga: Louisville, Kentucky.

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HIMEROCRINUS PLENISSIMUS
FOR EXPLANATION OF PLATE SEE PAGE 82.



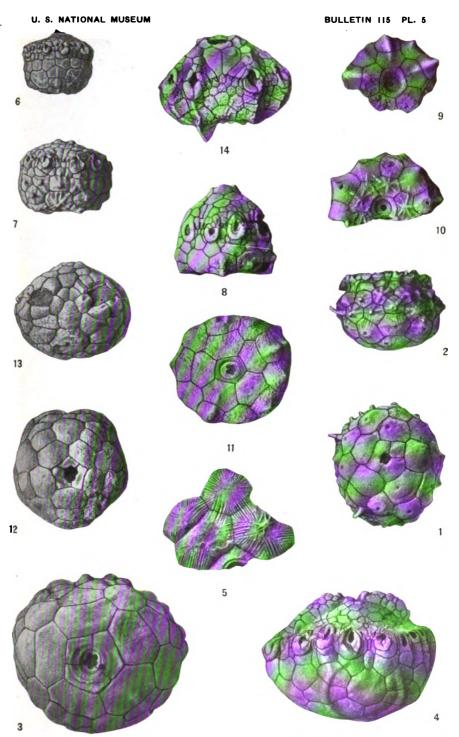


FOR EXPLANATION OF PLATE SEE PAGE 63.

PLATE 4.

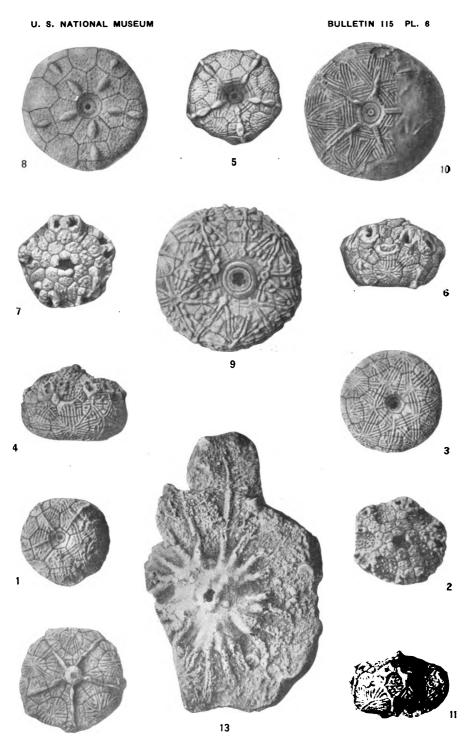
		HIMEROCRINUS PLENISSIMUS (Lyon)	Page. 12
Fig.	1.	Photograph of specimen with arms and stem, showing some of the small biserial arms to part of their length, and the nodal columnals with numerous coglike processes, and thin internodals appearing between them. Surface ornament on calyx removed by erosion, but the pits at the corners of the plates, and the lateral ridges along the radial series toward the arm bases, are conspicuous.	
	2.	Dorsal view of a specimen with plates well separated at the sutures, having the modified axillary primibrach in both three and four sided forms.	
	3.	Dorsal view of basal plates with several included column ossicles adhering at the bottom of the cavity, from which they have been detached as in figure 2, this being the condition in which they are frequently found.	
•	4.	Dorsal view of a base in same condition as the preceding, with some radials attached. Onondaga: Louisville, Kentucky.	
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	PLATE 5.	D
	TECHNOCRINUS NIAGARENSIS, new species	Page.
Fig.	 Basal and lateral views of the type; remnants of spines are seen in place, and sockets of others. Niagaran (Bob formation): Hardin County, Tennessee. 	
	STEREOCRINUS HELDERBERGENSIS, new species	15
	3, 4. Basal and lateral views of type.	
	5. Plates of another specimen, showing striate ornamentation. Helderbergian (Linden formation): Benton County, Tennessee.	
	DOLATOCRINUS LACUS Lyon	28
	6. A typical specimen, with characteristic outline; the arms are free on second secundibrach.	
	7. A larger specimen, with greater incorporation of brachials and more pinnule openings.	
	DOLATOCRINUS PYRAMIDATUS, new species	29
	 8, 9. Lateral and basal views of type, showing the characteristic contour, tapering upward from broad truncate base involving most of first primibrach and part of interbrachial; pinnule openings are strong. 10. Basal view of another specimen showing traces of stellate ornament, usually removed by erosion. 	
	11. The broad, truncate base of a larger specimen.	
	DOLATOCRINUS ROTUNDUS, new species	30
	12, 13. Basal and lateral views of type, showing the rotund contour, without angles or surface ornament.	
	DOLATOCRINUS MARSHI Lyon	31
	14. A typical specimen, with prominent pinnule openings.	
	All except Nos. 1-5 from the Onondaga of the Louisville area.	
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TECHNOCRINUS NIAGARENSIS, STEREOCRINUS HELDEBERGENSIS, DOLATOCRINUS LACUS, D. PYRAMIDATUS, D. ROTUNDUS, AND D. MARSHI.

FOR EXPLANATION OF PLATE SEE PAGE 84.



DOLATOCRINUS ORNATUS, D. ASPERATUS, AND D., SPECIES.

FOR EXPLANATION OF PLATE SEE PAGE 85.

PLATE 6.

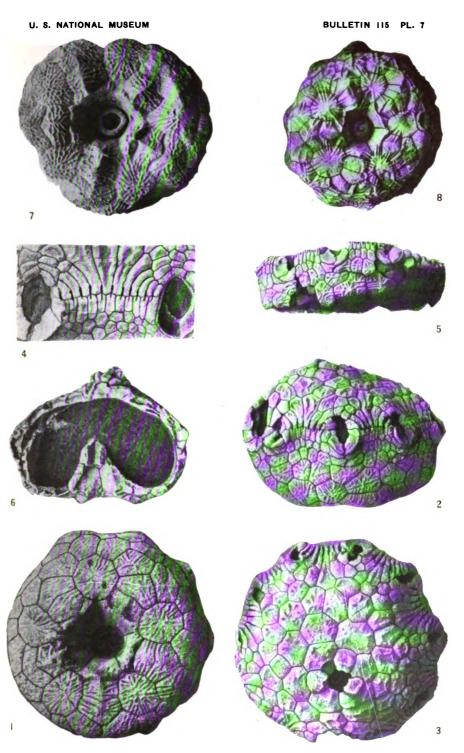
Page.	DOLATOCRINUS ORNATUS Meek
	Fig. 1. Basal view of the type, having small radial ridge. Columbia University, New York.
	2. Tegmen of another specimen, covered with small tubercles.
	3. Basal view of larger specimen, without any radial ridge.
	4. Lateral view of same, showing tubercles on tegmen, and projecting lip at the edge.
	Onondaga: Columbus, Ohio.
41	DOLATOCRINUS ASPERATUS Miller and Gurley
	 5, 6, 7. Basal, lateral, and tegmenal views of the type, showing radial ridge formed of connected nodes. University of Chicago, No. 6071. 8. A larger specimen, with large disconnected nodes and pitted surface
	ornament.
	 Large specimen with radial ridge not well defined; coarse pustules and small nodes more or less radiately arranged, tending to form geomet- rical figures.
	 Large specimen with narrow radial ridge limited to primibrachs; fine striae forming triangles.
	 Lateral view of specimen with continuous ridge extending to arms; fine striate ornament. Type of D. marshi, var. hamiltonensis Wachsmut and Springer.
	12. Basal view of similar specimen, showing continuous ridge.
	Among these six specimens, all having the same general form and proportions and 10 arms, are four different kinds of radial ridge, and three styles of surface ornament. Hamilton: Louisville area.
16	DOLATOCRINUS, species
	13. The tegmen of one of the few known specimens having parts of the arms and pinnules attached; it is imbedded, and the dorsal parts parts can not be seen.
	Hamilton: Louisville area.
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DOLATOCRINUS GRANDIS Miller and Gurley

- Figs. 1, 2, 3. Basal, lateral, and tegmenal views of a typical specimen with the most frequent type of surface ornament. It shows the large pentagonal basal funnel; the large iBr₁ distally angular with two large fixed pinnulars leading from IIBr₁ partly resting upon it; the position and succession of the fixed pinnules leading from the IIBr to the openings at the margin of the tegmen between the arms; also how the large biserial arm, for a distance of two or more biserial pairs of ossicles, is incorporated in the calyx wall.
 - 4. Detail of an interray of large specimen having 12 pinnule openings; it shows how the openings are formed where the sutures leading from the tegmen ambulacra meet the grooves at the distal end of the fixed pinnules. ×2.
 - Detail of another specimen showing succession of IIBr, and two biserial pairs of brachials, and the course of the fixed pinnules leading from them.
 - 6. A fractured cross section of the calyx, showing the inverted conical pit half the depth of the calyx, involving basals and radials.
 - Specimen with very sharp sculpturing, coarse wrinkles and an obtuse median ridge; also the basal pit with a section of stem in position.
 - 8. A variant, with a more distinctly striate ornament; it has in three interrays a truncate first interbrachial with another succeeding it, followed by two large pinnulars leading from IIBr₁, and in the other two the two large pinnulars resting directly on iBr₁, as usual in the species.

All Onondaga: Louisville area.

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DOLATOCRINUS GRANDIS.

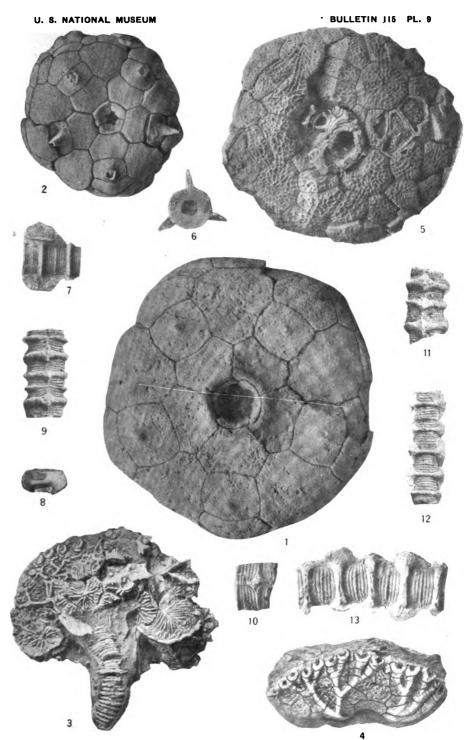
FOR EXPLANATION OF PLATE SEE PAGE 66.

DOLATOCRINUS SPINOSUS AND D. INSUETUS.

PLATE 8.	Dogo
DOLATOCRINUS SPINOSUS Miller and Gurley	Page. 34
Fig. 1. A specimen below average size; basal view, showing strong radial ridge limited to radial and IBr, and rather pitted ornament.	
Lateral view of same, showing stout spines on the tegmen, and pinnule openings between arm bases.	
3. A very young variant, with disproportionally high tegmen, and ridges extending to arms. Probably should be referred to <i>D. insuetus</i> —fig. 8 below.	
 A small specimen with extremely fine striate ornament, and very high knifelike ridges on radial and IBr. 	
 An average specimen with typical striate ornament, and usual shape of large iBr; remains of high radial ridges limited to IBr. 	
Another specimen with variation in shape of the large iBr, which is nearly acuminate instead of broadly truncate.	
Tegmen of the same, showing the broken-off bases of strong spines, the arrangement of plates, and position of pinnule openings.	
DOLATOCRINUS INSUETUS Rowley	36
 Basal view of specimen with perfect typical ornament, and showing the radial ridges extending to the arms; the knifelike projections of the ridge are broken off. 	
All Onondaga: Louisville area.	
183081—21——6	

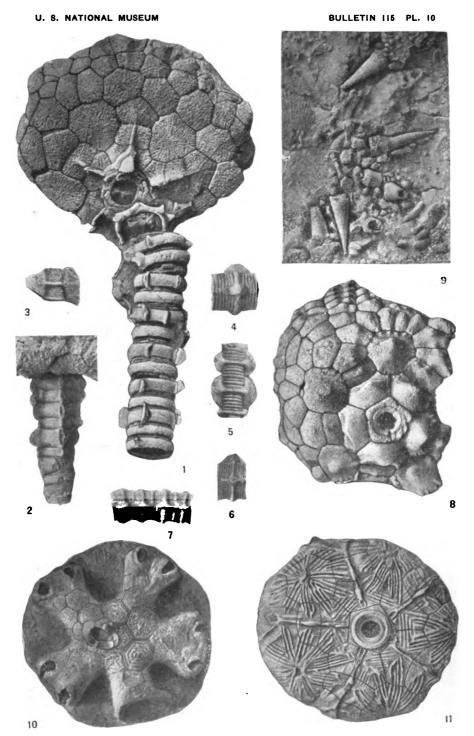
PLATE 9.

DOLATOCRINUS MAJOR Wachsmuth and Springer	Page.
 Fig. 1. A maximum specimen; basal view, showing basal plates nearly resorbed by growth of axial canal. 2. A minimum specimen, with basals in normal condition; nodes on IBr produced into spines. 	
DOLATOCRINUS MULTIBRACHIATUS Rewley	38
 A flattened specimen, with details of delicate ornament brought out by etching; very sharp thin ridges follow the radial series from base to arms, where 4 arm openings to the half ray are seen, indicating about 40 in all; inner core of stem attached, on which the peripheral flanges of the nodals are mostly broken away. Lateral view of another specimen, showing 8 arms to the ray. 	
DOLATOCRINUS GRANDIS Miller and Gurley	17,32
5. Specimen with pitted sculpturing, figured to show the displaced portions of stem seen in the basal pit, in which the flanged nodals with their peripheral cogs, and some internodals, are well exposed; and also the very large size of the axial canal proximal to the calyx. All Onondaga: Louisville area.	
DOLATOCRINUS, species; fragments of column	17,18
 6. Transverse view of stem fragment at joint face, probably from toward the distal end, showing the small size of the axial canal in that part compared with the proximal portion shown in the last figure. 7, 8. Two fragments showing the great size sometimes attained by the finlike cogs, which here arch over 10 or 12 internodals. 9. 10, 11, 12, 13. Various fragments showing the relation of the nodel and 	
9, 10, 11, 12, 13. Various fragments showing the relation of the nodal and internodal columnals, in different stages of development.	
All from Louisville area: Probably Hamilton.	
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DOLATOCRINUS MAJOR, D. MULTIBRACHIATUS, D. GRANDIS, AND D., SPECIES.

FOR EXPLANATION OF PLATE SEE PAGE 88.



DOLATOCRINUS SPINOSUS, D. GRANDIS, D. EXSTANS, D. LIRATUS, AND VARIOUS SPECIES.

FOR EXPLANATION OF PLATE SEE PAGE 69.

PLATE 10.

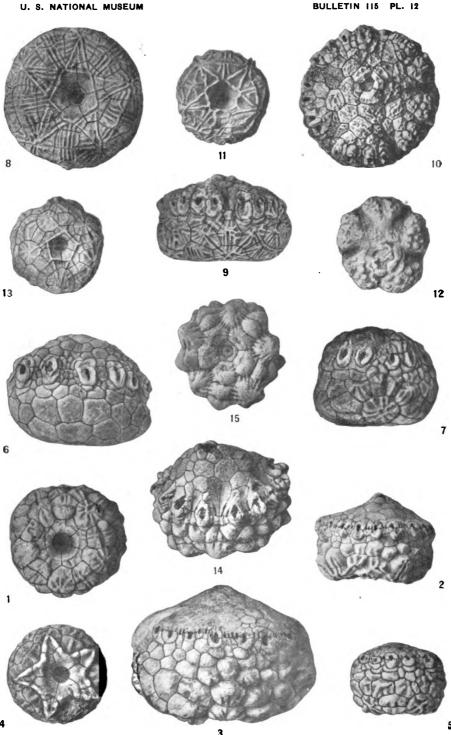
	Page.
DOLATOCRINUS SPINOSUS Müller and Gurley	17.34
Fig. 1. A very large variant of this species, figured to show the peculiar construction of the column, with nodals separated, and internodals of less diameter appearing between them.	
DOLATOCRINUS GRANDIS Miller and Gurley	17,32
Part of stem attached to a large calyx, with nodals in close contact, and cog-like processes forming continuous ridges.	
DOLATOCRINUS, various species	17,18
3-7. Stem fragments showing different stages of the nodal columnals, for comparison with the stems shown in the last two figures. Louisville area: Probably Hamilton.	
DOLATOCRINUS EXSTANS, new species	37
 Basal view of flattened specimen, showing the protuberant base. Tegmen of another specimen showing the long spines; it is flattened and has on the opposite side the same kind of base as shown in figure 8. Figs. 1, 2, 8, 9, from the Onondaga: Louisville area. 	
DOLATOCRINUS LIRATUS Hall	41
 10, 11. Tegmenal and basal views of two characteristic specimens from the Hamilton of western New York. 	
co	

PLATE 11.

DOLATOCRINUS BULBACEUS Miller and Gurley	Page.
 Fig. 1. Basal view of type. University of Chicago Coll., No. 6083. 2. Type of D. aspratilis Miller and Gurley. University of Chicago Coll., 	•
No. 6112. 3. Lateral view of another specimen, showing typical form and ornament, and pinnule openings close to edge of arm bases.	
DOLATOCRINUS ARGUTUS Miller and Gurley	44
4, 5. Basal and lateral views of type. University of Chicago Coll., No. 6079.	
DOLATOCRINUS STELLIFER Miller and Gurley	44
 Basal view of the type. University of Chicago Coll., No. 6088. The type of D. neglectus Miller and Gurley, showing typical surface ornament, and basal pit with pentagonal rim. University of Chicago Coll., No. 6091. 	
8. Lateral view of same, showing decanter shape.	
DOLATOCRINUS TRIADACTYLUS Barris	46
9, 10. Basal and lateral views of two typical specimens from Alpena, Michigan.	
DOLATOCRINUS AMPLUS Miller and Gurley	47
11. Basal view of the type, with center broken; has 20 arms. University of Chicago Coll., No. 6097.	
 Lateral view of same, showing characteristic tumid plates, and prominent pinnule openings. 	
13, 14. The type of <i>D. vasculum</i> Miller and Gurley; basal and lateral views; 18 arms. University of Chicago Coll., No. 6096.	
 The type of D. peculiaris Miller and Gurley, with 17 arms. University of Chicago Coll., No. 6085. 	
16. The type of D. lyoni Wachsmuth and Springer, with 15 arms.	
 Detail of interray of same, showing pinnule openings and slits leading to them. 	
Hamilton: All except figures 9 and 10 from the Louisville area in Clark County, Indiana.	
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VARIOUS SPECIES OF DOLATOCRINUS.

FOR EXPLANATION OF PLATE SEE PAGE 70.



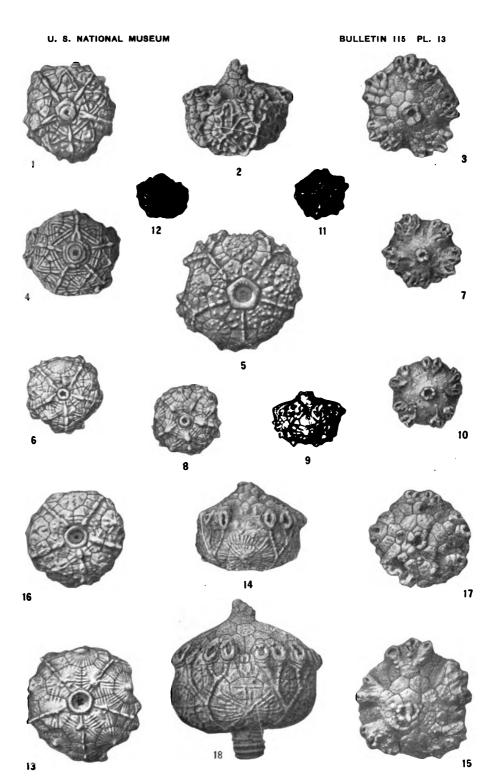
DOLATOCRINUS COSTATUS, D. ASTERIAS, D. INCISUS, AND D. AMPLUS.

FOR EXPLANATION OF PLATE SEE PAGE 71.

PLATE 12.

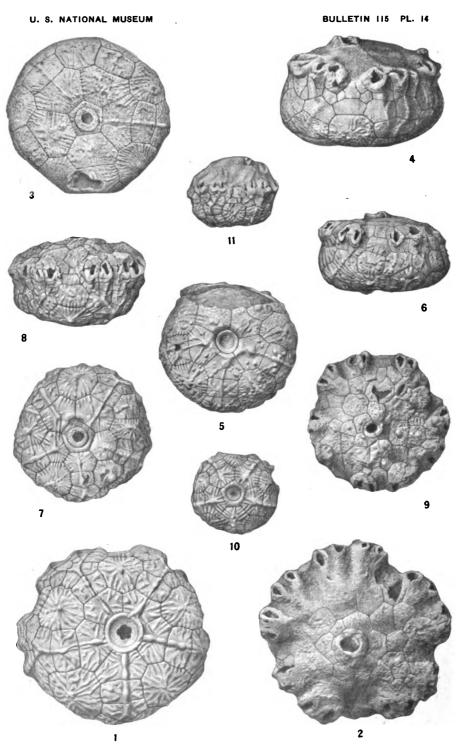
Page.	I DATE 12.
48	DOLATOCRINUS COSTATUS Wood
	 Figs. 1, 2. Basal and lateral views of a rather small specimen showing the tumid, wrinkled cup plates, smooth tegmen, and prominent pinnule openings. 3. A very large specimen, with extremely rugose plates in basal portion,
	not well shown in the figure.
48	DOLATOCRINUS ASTERIAS Wood
	4, 5. Basal and lateral views of medium sized specimen.6. 7. Variants above the usual size.
49	DOLATOCRINUS INCISUS, new species
	 3, 9, 10. Basal, lateral, and tegmenal views of a maximum specimen, showing the sharply incised striate or wrinkled ornament, rugose tegmen, basal pit with pentagonal rim, and 20 arms. 11, 12. Basal and tegmenal views of a smaller specimen with coarser striæ.
	13. Another specimen with simpler lines of ornament.
47	DOLATOCRINUS AMPLUS Miller and Gurley
	 14. Specimen from Louisville, with nodose plates and prominent pinnule openings, for comparison with costatus. 15. Base of another specimen, with sculpturing of plates very distinct. All Hamilton, and from Alpena, Michigan, except figs. 14
	and 15.
	₩1

PLATE 13.	D
DOLATOCRINUS VENUSTUS Miller and Gurley	Page.
Figs. 1, 2, 3. Basal, lateral, and tegmenal views of the type. University of Chicago Coll., No. 6094.	
 A specimen from Alpena, Michigan, with more strictly striate ornament. 	
 The type of D. aureatus Miller and Gurley, with ornament of more isolated pustules. University of Chicago Coll., No. 6082. 	
DOLATOCRINUS BELLARUGOSUS Müller and Gurley	56
 The type; basal and tegmenal views. University of Chicago Coll., No. 6087. 	
8, 9, 10. The type of <i>D. coclatus</i> Miller and Gurley. University of Chicago Coll., No. 6093.	
DOLATOCRINUS EXORNATUS Miller and Gurley	5 1
11, 12. Basal and lateral views of one of several specimens of the type of D. dispar Miller and Gurley, having usually 18 to 20 arms, and of uniformly small size; the type of exornatus is lost.	
DOLATOCRINUS LINEOLATUS Miller and Gurley	58
13, 14, 15. The type; basal, lateral, and tegmenal views. University of Chicago Coll., No. 6080.	
16, 17. Basal and tegmenal views of the type of D. cistula Miller and Gurley. University of Chicago Coll., No. 6098.	
18. The type of D. eicosidactylus Wachsmuth and Springer.	
All Hamilton, and all except figure 4 from the Louisville area.	
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DOLATOCRINUS VENUSTUS, D. BELLARUGOSUS, D. EXORNATUS, AND D. LINEOLATUS.

FOR EXPLANATION OF PLATE SEE PAGE 72.



DOLATOCRINUS CORPOROSUS, D. INDIANENSIS, D. GREENEI, AND D. LINEOLATUS.

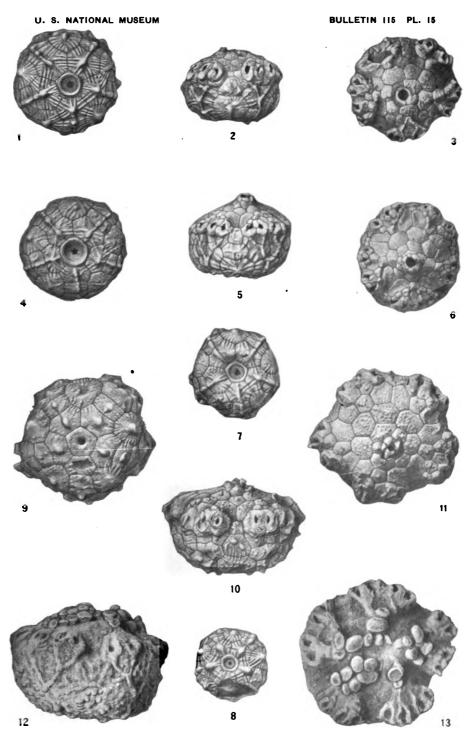
FOR EXPLANATION OF PLATE SEE PAGE 73

PLATE 14.

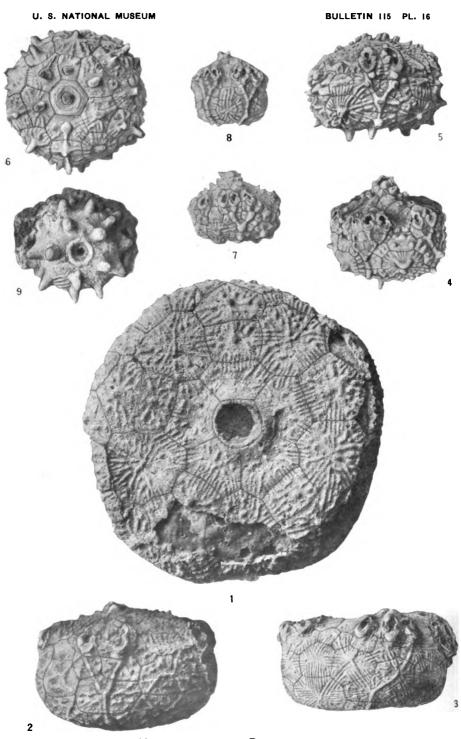
DOLATOCRNUS CORPOROSUS Miller and Gurley	Page. 54
Figs. 1, 2. Basal and tegmenal views of the type. University of Chicago Coll., No. 6106.	
DOLATOCRINUS INDIANENSIS Miller and Gurley	54
 The type; basal and lateral views. University of Chicago Coll., No. 6099. 	
 6. The type of D. preciosus Miller and Gurley. University of Chicago Coll., No. 6072. 	
DOLATOCRINUS GREENEI Miller and Gurley	
7, 8, 9. Basal, lateral, and tegmenal views of the type. University of Chicago Coll., No. 6095.	
DOLATOCRINUS LINEOLATUS Miller and Gurley	5.
 10, 11. The type of D. sacculus Miller and Gurley. University of Chicago Coll., No. 6078. 	
All Hamilton: Louisville area.	
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PLATE 15.

Page.	I LATE 13.
Page. 56	DOLATOCRINUS BELLULUS Miller and Gurley
	Figs. 1, 2, 3. Basal, lateral, and tegmenal views of a typical specimen so labeled by Mr. Miller. University of Chicago Coll. The type is lost.
	 5, 6. Similar views of type of D. basilicus Miller and Gurley. University of Chicago Coll., No. 6090.
55	DOLATOCRINUS LINEOLATUS Miller and Gurley
	 The type of D. salebrosus Miller and Gurley. University of Chicago Coll., No. 6103.
50	DOLATOCRINUS VENUSTUS Miller and Gurley
	 The type of D. arrosus Miller and Gurley. University of Chicago Coll., No. 6105.
56	DOLATOCRINUS NODOSUS Miller and Gurley
	9, 10, 11. Basal, lateral, and tegmenal views of the type. University of Chicago Coll., No. 6081.
57	DOLATOCRINUS FUNGIFERUS Rowley
	12, 13. A specimen showing the mushroom-shaped spines; lateral and tegmenal views.
	All Hamilton: Louisville area.
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VARIOUS SPECIES OF DOLATOCRINUS.
FOR EXPLANATION OF PLATE SEE PAGE 74.



VARIOUS SPECIES OF DOLATOCRINUS.

FOR EXPLANATION OF PLATE SEE PAGE 75.

PLATE 16.

	AMALE IV.	Page	
	DOLATOCRINUS CORPOROSUS Miller and Gurley		
ΉG.	 A flattened specimen of maximum size; ornamentation somewhat finer than in the type. 		
	 A 10-armed variant; being a typical example of the bursiform calyx characteristic of the magnificus group, and of the pustulose style of ornament of this species, but having only 10 arms. 		
	DOLATOCRINUS GREENEI Miller and Gurley	85	
	3. A good-example of the fine striate ornament attributed to this species; owing to some distortion the true contour of the calyx does not appear in this view.		
	DOLATOCRINUS BELLULUS Miller and Gurley	56	
	4. A typical example of this species, with the strong nodose ornamentation.		
	 A 10-armed variant; similar to the last in all essential characters, but having 10 arms, and being abnormal in the base. 		
	 Basal view of same specimen, having a hexagonal base with a sixth plate in line with the radials, like the anal plate of the Actino- crinidae. 		
	7. A young specimen, for comparison with the next figure.		
	DOLATOCRINUS LINEOLATUS Miller and Gurley	. 55	
	8. A young specimen, showing greater relative height of calyx.		
	DOLATOCRINUS, species	. 56	
	 An imperfect specimen, having an extreme development of the central nodes. 	1	
	All Hamilton: Louisville area.		
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SMITHSONIAN INSTITUTION UNITED STATES NATIONAL MUSEUM Bulletin 116

THE DIPTEROUS GENUS DOLICHOPUS LATREILLE IN NORTH AMERICA

BY

M. C. VAN DUZEE, F. R. COLE

AND

J. M. ALDRICH



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The *Proceedings*, the first volume of which was issued in 1878, are intended primarily as a medium for the publication of original, and usually brief, papers based on the collections of the National Museum, presenting newly acquired facts in zoology, geology, and anthropology, including descriptions of new forms of animals, and revisions of limited groups. One or two volumes are issued annually and distributed to libraries and scientific organizations. A limited number of copies of each paper, in pamphlet form, is distributed to specialists and others interested in the different subjects, as soon as printed. The dates of publication are recorded in the tables of contents of the volumes.

The Bulletins, the first of which was issued in 1875, consist of a series of separate publications comprising chiefly monographs of large zoological groups and other general systematic treatises (occasionally in several volumes), faunal works, reports of expeditions, and catalogues of type-specimens, special collections, etc. The majority of the volumes are octavos, but a quarto size has been adopted in a few instances in which large plates were regarded as indispensable.

Since 1902 a series of octavo volumes containing papers relating to the botanical collections of the Museum, and known as the *Contribu*tions from the National Herbarium, has been published as bulletins.

The present work forms No. 116, of the Bulletin series.

WILLIAM DEC. RAVENEL,
Administrative Assistant to the Secretary,
in charge of the United States National Museum.

WASHINGTON, D. C., November 15, 1920.

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THE DIPTEROUS GENUS DOLICHOPUS LATREILLE IN NORTH AMERICA.

By M. C. VAN DUZEE, F. R. COLE, AND J. M. ALDRICH.

INTRODUCTION.

By J. M. ALDRICH.

The dipterous family Dolichopodidae offers such a storehouse of material bearing upon the Darwinian theory of sexual selection that its many beautiful and easily classified species ought to be much more widely known among those who give attention to the larger biological problems. In the present paper a large number of secondary sexual characters are figured, not only as aids to identification, but to give some idea of the wealth of beautiful structures which have been developed in the males of this genus. The species are so abundant and accessible everywhere in the United States and Canada, as well as Europe, that their peculiar mating habits ought to be recorded for many, instead of the five which are given a few paragraphs farther on.

The family is readily distinguished by a few characters. Its members have antennae with three simple joints and an arista; the tarsi with empodia not pulvilliform; palpi with only one joint; basal cells of wing very small, the second confluent with the discal, anterior cross-vein close to base of wing. The species almost universally have bright metallic green and blue colors.

Among the genera of this family are two which are strikingly rich in species—Psilopus, with a widely divergent fork on the third vein, which is widespread in the tropics everywhere, and occurs also in temperate zones; and Dolichopus, recognized by having several spines on the upper side of the hind basitarsi, which has a circumpolar distribution in the northern hemisphere, extending southward pretty well across the north temperate zone.

The presence of the spines just mentioned on the upper side of the hind basitarsi is a sufficient diagnostic character to separate the genus Dolichopus from all others known in North America; it would serve equally well throughout the species of the rest of the world by adding that the arista is never plumose. The Ethiopian and oriental Rhagoneurus Loew (Lichwardtia Enderlein, 1912) has a plumose arista and a single spine on the hind basitarsus.

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The first antennal joint is hairy above; the vertex not much hollowed, never obliterated by the approximation of the eyes; thorax slightly compressed, rather high in front, with short, rounded scutellum; abdomen also somewhat compressed, the male hypopygium long, bent forward under the venter. Hind cross-vein about in the middle of the wing field (disregarding the narrow basal portion); fourth vein rather strongly bicurved beyond it, rarely with one or both of the curves extending into a short stump, ending in or more often well before the apex. The accompanying figure (fig. 1) shows well the general characters.

For purposes of classification the characters fall very readily into two groups, those which occur only in the male and those which occur in both sexes. Of the former there are very many, and in general they are easy to see and very striking; hence the males are much easier to identify than the females. Characters available for both sexes are color of legs and antennae; color of the infra-orbital cilia—a row of erect small hairs behind the eye, the upper ones of which are always black; color of the cilia of the calypters—delicate outstanding hairs on the little padlike organ just below and behind the wing; usually the venation; and some others.

Male characters occur in many places; the antennae may be elongated or swollen, the arista may have the appearance of a spearhead at apex, the face may be bright silvery or pure brown in its pollen, and elongated below; the front tarsi may be long or short in various joints, and often are compressed and enlarged on the apical one, two, or three joints, which may be white, black, or silvery; the front empodia may be plumelike; the middle tarsi or even the hind ones may be ornamented instead of the front ones; the tibiae sometimes partake of the ornamentation of their tarsi; the hind femora may bear long cilia below, light or dark; the costa may be variously thickened; the apical half of the wing may contain a distinct black spot or a dark shade; and the posterior margin of the wing toward the base is often excised, emarginate or lobed. There are a few other characters of this class. The lamellae of the hypopygium have numerous peculial modifications.

Most of these characters are distinctly of the nature of male ornaments. In several cases the male has been observed to display them before the female very assiduously. In the American Naturalist, I described the behavior of *Dolichopus tenuipes* Aldrich (it was then an undescribed species) and of *D. crenatus* Osten Sacken. I quote these observations in order to bring together all the information that I have relating to these habits in the genus:

[Dolichopus tenuipes Aldrich] has the fore tarsi in the male exceedingly elongated and slender, with the last joint in the shape of a comparatively large, oval black disk

¹ Vol. 28, 1894, 35-37.

[fig. 207a, this article] * * * I observed in September the maneuvers of the male in courting the female. He would place himself directly in front of her, at a distance of about half an inch, with his face toward her. He would then rapidly vibrate his wings, holding them horizontally at right angles to the body; and at the same time would give these fore feet an up and down motion, raising them simultaneously to the level of the head and bring them down with a slight force upon the ground, the movement recurring in a measured way in about half a second. This he would continue for about 10 seconds; then, rising on the wing, he would swiftly make a small semicircle in the air and attempt to alight upon the female. In the large number of cases that I observed, he was always unsuccessful, the female hastily moving away

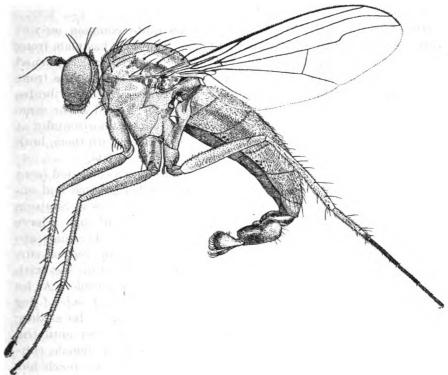


FIG. 1.—DOLICHOPUS BOLSTERI, NEW SPECIES.

a few inches, when the male would usually alight before her and repeat the movements. * * I saw the same maneuver repeated hundreds of times. * * *

In company with the species just mentioned occurred considerable numbers of * * * creatus O. S. These were engaged in a similar occupation. The male of this species has only plain tarsi, but differs from the female in having the antennal joints longer, the first two with coarse black hair, and the arists of the third joint heavily covered with a black pubescence [fig. 159a, this article]; the face is also longer, the wings broader, and the cilia of the calypters, instead of being coarse and chiefly black, are fine and white. The male hovers in the air before the female at a distance of one or two inches, occasionally making a slight darting motion towards her. In this position the peculiarities of his face and antennae are shown to the best advantage.

In the Zoologischer Anzeiger for April, 1889, Friedrich Dahl has described the actions of *Dolichopus plumipes* Scopoli, as he observed

them in Germany. The species is common also in the United States. I translate as follows:

The male of the fly possesses on the first tarsal joint a beautiful, regular fringe [the fringe is on middle tibia and tarsus, our fig. 128a—J. M. A.], the purpose of which is not immediately perceptible. * * * I have now observed the pairing of these insects, and am convinced that the structure serves as an actual ornament to the male. * * * The male came flying up, and hovered for a time so close over the quietly resting female that the fringed tarsi hung down immediately before her eyes.

I can add similar observations on two more species, not hitherto published.

Dolichopus aldrichii Wheeler is a species quite common on wet earth at edge of water at Moscow, Idaho. The male has plain front tarsi, but the middle ones (fig. 182a) are elongated and thickened and very black. The male takes up a position on the earth in front of the female and facing her, an inch or so away. He then vibrates his wings, holding them at right angles to the body, and at the same time elevates the long middle legs, holding them also horizontally at right angles to the body, and describes a small circle with them, both together, very like the setting up drill of military cadets.

Dolichopus longimanus Loew is a species with much elongated front tarsi (fig. 138a, last four joints), the last joint being black and enlarged. I observed the courtship on the trunks of trees at Simpson Park, Big Stone City, South Dakota, in 1896, and although I have no notes I believe I can record the facts even yet. The male approaches the female directly from behind (below, as on vertical surfaces they always face upward); he walks on the tips of his toes with his front feet, assuming in consequence a reared-up attitude. As he comes to the female he advances his front tarsi on each side of her until their tips are even with her head, which is about as far as they can be extended. Then he deliberately raises the tarsi until the enlarged apical joint touches on each side the eye of the female, continuing the movement upward. But just as his tarsi touch her eyes, he advances his hypopygium and attempts to grasp the tip of her abdomen. She immediately dodges away, and the performance is repeated.

In the five species reported, it will be noted that the movements are quite different for each. There is no doubt whatever that many other species can very easily be observed in their characteristic behavior.

The larval habits are very slightly known for the entire family, and especially for this genus, a surprising fact when the abundance of adults is considered. Hart ² describes three undetermined larvae, which Malloch, ³ refers to *Dolichopus*, giving a figure of one of them. ⁴ One was taken boring in decaying and watersoaked stems of rushes,

²Bull. Ill. State Lab. N. H., vol. 4, 1895, p. 268.

³Idem., vol. 12, 1917, p. 406.

⁴Pl. 57, fig. 3.

floating in water near Havana, Illinois; the second was taken with dip net and sieve from mud at bottom of the Illinois River at Havana; the third from earth in bottom land in the same vicinity. From the great abundance of adults at edge of water on mud in Idaho, I had long supposed that the larvae must breed in rich, wet earth; if there had been any truly aquatic forms there I must have seen them.

The larvae are maggot-like, with eleven segments behind the poorly developed head, of which five or six bear fleshy protuberances for locomotion on the under side, provided with hooks, but imperfectly paired, end of abdomen with two upper and two lower lobes, the small posterior spiracles on the upper; anterior pair of spiracles very minute. The head is of peculiar reduced structure, with vertical hooks inside an open chitinous frame. The classical description is of *Dolichopus ungulatus* (as aeneus) by Brauer.⁵ This larva was found in decomposing wood inside a hollow tree.

The adults, as already remarked, are most abundant at the edge of water on mud; some species, however, are regularly found on foliage in half-shady places. Few are ever found in dry localities. They are very local, and even those species which have been collected in a dozen States are only to be found in just the right situation with regard to sunlight, moisture, and vegetation; a few feet away the search may be vain.

The species are most numerous in decidedly cold regions, either far north or in high altitudes southward. Two species are recorded from Mexico, myosota from Northern Sonora and bifractus from Mexico City, the latter being so far the extreme southern record for the genus (old South American and Mexican references always turning out to belong to species of other genera). A few species have been found in the northern (palaearctic) edge of Africa, probably none south of the thirtieth parallel, the latitude of New Orleans.

The Catalogue of Palaearctic Diptera, 1903, lists 119 species in the Old World, almost all from Europe. Siberia has hardly been touched yet, but is undoubtedly very rich in this genus. The present paper recognizes no fewer than 219 species and varieties from North America—a total of nearly 338 species and varieties thus far known (only a few forms are regarded as varieties).

It might be doubted whether such a vast number could properly be classified as belonging to the same genus. The fact is that every attempt at a division has been completely unsuccessful. Loew separated Hygroceleuthus on the length of the face, which turns out to be a male character occurring in some species otherwise quite far apart; although Lundbeck retained this in his monograph he admitted that it has slight value. Bigot proposed Spathichira for the species with

⁵ Denkschr. Kais. Akad. Wiss., Vienna, vol. 47, 1882, pp. 29, 30, 44, pl. 4, figs. 72-75.

notably enlarged fore or middle tarsi, but the enlargement, besides being purely a male character, is of every degree down to nothing, and in several cases two species can be selected which differ only in very minute characters or none, except that the male of one has enlarged fore tarsi and the other has them plain. Rondani proposed Ragheneura for a species with the bend of fourth vein angulated, a very unstable character. Frey in a paper on the European species cited below proposes to divide the genus into four subgenera, as follows:

All femora yellow:

Infraorbital cilia black Dolichopus s. str.
Infraorbital cilia whitish Eudolichopus Frey.

Femora more or less black:

Infraorbital cilia whitish Leucodolichopus Frey. Infraorbital cilia black Melanodolichopus Frey.

He offers these divisions for convenience in grouping the numerous species, conceding that the characters used have slight morphological value. For our fauna, however, the division on the color of the femora is worthless, as we have several types of partial infuscation of these members; the tips of the hind femora may be infuscated, the bases of the front ones only, etc. We have also several species (crenatus, etc.) in which the infraorbital cilia are pale in the males, but black in the females. While these characters are used in our tables, they are not generic in any degree. In fact, the more species we know the more homogeneous this remarkable group appears. The specific characters are beautifully distinct in most cases, but mostly sexual. This species are very easy to identify from males and no advantage could result from drawing lines where nature apparently has drawn none.

The present paper is the consummation of work in which I have been interested for 30 years. During the winter of 1889-90, when a student in Professor Cook's laboratory in the Michigan Agricultural College, I decided to take up the Diptera as a specialty. As a beginning I tried my hand with the old Smithsonian monographs of Loew and Osten Sacken, and found that I got along best with the one on the Dolichopodiae, by the aid of which I could determine a fair number of species, especially in Delichepus. This roused my interest in the group, and I began to collect in it actively; so that, when I went to Kansas to study in January, 1893, I took along a considerable named collection and some undescribed species in this genus. Combining this with the University of Kansas collection, I prepared a revision which included 22 new species. In the autumn of 1893 I went to Idaho, and during my residence there of 20 years I had opportunities to collect these beautiful insects in many parts of the West. I accumulated so many species that another revision became desirable; but the undertaking had grown so large that I could not find time to write the descriptions, nor could I make the drawings so necessary to illustrate the many interesting sexual characters involved. At length I hit upon the idea of a joint paper, Mr. Van Duzee to prepare the text except the introduction, and Mr. Cole the figures. Both of these colleagues, so admirably qualified for the respective parts, responded enthusiastically, and I turned over my whole collection, amounting to 139 species, to them. Mr. Van Duzee, moreover, had collected in the family very energetically about Buffalo, New York, and during a trip to the Pacific coast. By further active collecting, by obtaining material from collectors and by visiting the large museums, he succeeded in adding more than 50 per cent to the collection that he received from me. Mr. Cole also obtained new western material.

Both the present work and my revision of 1893 are built upon the foundation of Loew's monograph of 1864. A considerable list of early descriptions which Loew discussed at length and was unable to identify, the types being either destroyed or in European museums, are not herein mentioned at all; they will be found in Loew, and in my Catalogue of North American Diptera of 1905. Loew's types are in the Museum of Comparative Zoology, Cambridge, Massachusetts; they were examined by me in 1901, and in recent years by Mr. Van Duzee. Both of us also studied the types in the American Museum of Natural History, New York City.

As far as possible the type of each new species has been placed in the United States National Museum, while there are comparatively few of the previously known species not found here; making in all almost 200 species represented. Acknowledgment is due to many collectors for their donations of type material, but especially to Mr. Van Duzee himself.

The technical history of the genus will be found in the following bibliography:

BIBLIOGRAPHY OF GENUS DOLICHOPUS LATREILLE.

- 1796. Latreille, Précis des Caract. Gén., p. 159 (without species.)
- 1802. Latreille, Hist. nat. des Crust. et Ins., vol. 3, p. 439 (includes Musca ungulata Linnaeus and Musca nobilitata Linnaeus).
- 1803. Meigen, Illiger's Mag., vol. 2, p. 272, (Satyra, with one species, Musca ungulata Linnaeus).
- 1804. Latreille, Hist. nat. des Crust. et Ins., vol. 14, p. 333 (includes only *Musca unquiata* Linnaeus).
- 1810. Latreille, Consid. générales, p. 443 (mentions Musca ungulata Linnaeus as type of genus).
- 1823. Fallen, Dolichopodes, p. 7 (wide sense, many species).
- 1824. Meigen, Syst. Beschr., vol. 4, p. 74 (wide sense).
- 1842. Staeger, Kröyer naturh., Tidsskrift., 44 pp. (monograph of Danish species, a 4-page addition the next year).
- 1843. Zetterstedt, Dipt. Scand., vol. 2, p. 493 (wide sense, extensive analysis of species).
- 1856. Rondani, Prod. Dipt. Ital., vol. 1, p. 144 (Ragheneura, type Doliehopus griseipennis Stannius).
- 1861. Loew, Neue Beitr., vol. 8, pp. 1, 5 (limits on the character of bristles on hind basitarsus, and separates Hygroceleuthus, new genus (type latipes, new species) from this).
- 1862. Schiner, Fauna Austr., Diptera, vol. 1 (as preceding).
- 1864. Loew, Mon. N. A. Dipt., vol. 2, pp. 17, 29 (same).
- 1893. Aldrich, Kans. Univ. Quart., vol. 2, pp. 1 and 23 (Dolichopus and Hygroceleuthus)
- 1897. Wheeler, Proc. Cal. Acad. Sci., ser. 3, vol. 2, p. 2 (analysis of Hygroceleuthus).
- 1900. Melander and Brues, Biological Bill., vol. 1, p. 124 (regard Hygroceleuthus as a subgenus).
- 1905. Aldrich, Catalogue of N. A. Dipt., p. 298 (makes it a synonym).
- 1908. Aldrich, in Williston, Manual of N. A. Dipt., p. 232 (in table).
- 1912. Lundbeck, Dipt. Danica, vol. 4, pp. 51, 57 (Hygroceleuthus and Dolichopus, beautifully monographed for Denmark).
- 1915. Frey, Acta pro Fn. et Fl. Fennica, vol. 40, No. 5, p. 10 (subgenera).

Coquillett, Type-species N. A. Diptera, 1910, p. 535, adopts the assertion of Hendel, Verh. Zool.-Bot. Ges. Wien, 1908, p. 57, and includes as a synonym *Iphis*, Meigen, Nouv. Class., 1800, p. 27. Aside from any other objections to the availability of this name, it applies distinctly to species having an apical arista and hence can not be the same as *Dolichopus*. In any event it would not disturb nomenclature here.

While the present paper was in press, the writer received, on August 30, 1920, a new monograph of the Dolichopodidae of the palaearctic region (Europe, Siberia, etc.), by the well-known dipterist Mr. Theodor Becker, of Liegnitz, Prussia. This is published in three parts in the Nova Acta, Abhandlungen der Leopoldinisch-Carolinischen Deutschen Akademie der Naturforscher, as follows: Band 102, No. 2, 1917; Band 103, No. 3, 1918; and Band 104, No. 2, 1918. The genus *Dolichopus* is treated in the first part, pp. 126–180, and 127 species are recognized, of which 3 are placed in the subgenus *Hydroceleuthus*.

CLASSIFICATION.

By M. C. VAN DUZEE.

TABLE OF THE NORTH AMERICAN SPECIES OF DOLICHOPUS.

MALES (for females, see p. 26).

Division into Groups.

 A¹. Femora largely black, at least one pair mainly black. B¹. Infra-orbital cilia black.
C1. Cilia of calypters pale
C ² . Cilia of calypters black
B ² . Infra-orbital cilia pale.
C ¹ . Middle tibiae black
C2. Middle tibiae yellow
A ² . Femora yellow, at most the tipe of the hind ones black.
B¹. Infra-orbital cilia black
B ² . Infra-orbital cilia pale.
C ¹ . Cilia of the calypters pale
C ² . Cilia of the calypters black.
D¹. Hind tibae distinctly black at tip
D ² . Hind tibiae not or but slightly infuscated at tip.
E ¹ . Hind tarsi wholly black
E2. Hind tarsi distinctly yellow at base
_ ·
Group A.
Hind tibiae yellow, with sharply defined black tip; costa without distinct enlargement at tip of first vein
G P
Group B.
1. Anterior basitarsi with a row of erect bristles below (Indiana).
 Anterior basitarsi with a row of erect bristles below (Indiana). No. 49, retinens, new species.
1. Anterior basitarsi with a row of erect bristles below (Indiana). No. 49, retinens, new species. Anterior tarsi without such bristles
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1. Anterior basitarsi with a row of erect bristles below (Indiana). No. 49, retinens, new species. Anterior tarsi without such bristles. 2. Middle femora at least half yellow, or yellowish. None of the femora with more than apical third yellow. 12. Middle femora black at base, gradually becoming yellow, but largely blackish; lamellae small and infuscated. 4.
1. Anterior basitarsi with a row of erect bristles below (Indiana). No. 49, retinens, new species. Anterior tarsi without such bristles. 2. 2. Middle femora at least half yellow, or yellowish. 3. None of the femora with more than apical third yellow. 12. 3. Middle femora black at base, gradually becoming yellow, but largely blackish; lamellae small and infuscated. 4. Middle femora wholly yellow, or with the black more distinctly limited. 5.
1. Anterior basitarsi with a row of erect bristles below (Indiana). No. 49, retinens, new species. Anterior tarsi without such bristles. 2. 2. Middle femora at least half yellow, or yellowish. 3. None of the femora with more than apical third yellow. 12. 3. Middle femora black at base, gradually becoming yellow, but largely blackish; lamellae small and infuscated. 4. Middle femora wholly yellow, or with the black more distinctly limited. 5. 4. Third and fourth veins of the wing quite close together at their tips, ap-
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1. Anterior basitarsi with a row of erect bristles below (Indiana). No. 49, retinens, new species. Anterior tarsi without such bristles. 2. 2. Middle femora at least half yellow, or yellowish. 3. None of the femora with more than apical third yellow. 12. 3. Middle femora black at base, gradually becoming yellow, but largely blackish; lamellae small and infuscated. 4. Middle femora wholly yellow, or with the black more distinctly limited. 5. 4. Third and fourth veins of the wing quite close together at their tips, approaching each other beyond the bend in fourth (Wisconsin). No. 57, umbrosus, new species.
1. Anterior basitarsi with a row of erect bristles below (Indiana). No. 49, retinens, new species. Anterior tarsi without such bristles. 2. 2. Middle femora at least half yellow, or yellowish. 3. None of the femora with more than apical third yellow. 12. 3. Middle femora black at base, gradually becoming yellow, but largely blackish; lamellae small and infuscated. 4. Middle femora wholly yellow, or with the black more distinctly limited. 5. 4. Third and fourth veins of the wing quite close together at their tips, approaching each other beyond the bend in fourth (Wisconsin).

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5.	Hind femora yellow except dorsal and part of ventral edge (Idaho).
	No. 63, opportunus, new species.
_	Hind femora black, the tip may be yellow. 6.
б.	Fore femora mostly yellow (E. States; Canada)No. 67, flavilacertus, new species.
7.	Fore femora largely black, at least black at base for nearly half their length 7. Fourth joint of middle tarsi distinctly compressed (New York; Illinois).
	No. 54, remus, new species.
	All tarsi plain 8.
8.	Hind tibiae wholly black (New Jersey)
	Hind tibiae with basal portion yellow 9.
9.	Middle femora distinctly blackened at base
	Middle femora not, or but slightly infuscated at base
10.	Face ochraceous (Greenland; Labrador)No. 52, groenlandicus Zetterstedt.
	Face silvery (Wisconsin; New York)
11.	Middle and hind femora each with two preapical bristles; third antennal joint
	about one and a half times as long as wide (Idaho).
	No. 38, bisetosus, new species.
	Middle and hind femora each with one preapical bristle; third antennal joint two
	or three times as long as wide (New York; Massachusetts).
_	No. 55, adultus, new series. Anterior tibiae black or blackish
12.	Anterior tibiae black or blackish
	Anterior tibiae yellow or yellowish brown
13.	Last joint of fore tarsi compressed
٠.	Fore tarsi plain
14.	Fifth joint of fore tarsi obcordate, second and third joints usually yellowish
	(Colorado; New Mexico)
75	Fore tarsi wholly black, fifth joint not notched at tip
15.	First antennal joint yellow below; fifth joint of fore tarsi cut off rather straight at tip (California)
	Antennae wholly black; fifth joint of fore tarsi extended a little at upper edge
	(California)
18	Middle basitarsi wholly black 18.
10.	Middle basitarsi mostly white
17	Wings with a conspicuous blackish spot near the tip (Washington).
	No. 23, argentipes, new species.
	Wings without any trace of such a spot (Alaska; Labrador; North Europe).
	No. 22, stenhammari Zetterstedt.
18.	Hind femora ciliated on lower inner edge (California; Oregon),
	No. 17, paluster Melander and Brues.
	Hind femors without cilis
19.	Lamellae of the hypopygium blackish (Colorado)No. 3, barbaricus, new species
	Lamellae whitish with a black border (Washington; British Columbia).
	No. 2, monticola, new species.
20.	Hind tibise distinctly yellow for more than one-third their length, at least on
	one side
	Hind tibiae infuscated, at most a little yellow at base
21.	Third antennal joint about three times as long as wide; arists subapical; lamellae
	of hypopygium blackish (Illinois)No. 39, intentus Melander and Brues.
	Third antennal joint not over one and a half times as long as wide; arista dorsal;
	lamellae whitish
22.	Costa with a long, tapering enlargement at tip of first vein (Eastern States).
	No. 29, gratus Loew.
00	Costs without an enlargement at tip of first vein
Z3.	Hind femora ciliated below 24. Hind femora without cilia
	mind temors without chis

24.	Cilia of hind femora as long as the width of the femora (Labrador).
	No. 43, packardi, new species.
	Cilia of hind femora not much over half as long as the width of the femora 25.
25.	Lamellae of hypopygium with a large, almost angulated, upward projection at
	spex (New York)
	Lamellae somewhat triangular, with a very small projection above at apex
	(Louisiana; Indiana)
26.	Head without any yellow bristles below near the proboscis; wings with a brown
	cloud (Nevada)
	Head with two or three yellow bristles below near the proboscis; wings without
	a brown cloud. (New York)
27.	Lamellae of the hypopygium small, wholly black (Idaho).
	No. 25, beatus, new species.
	Lamellae of normal size, not wholly black
28.	Wings grayish hyaline (Eastern States)
	Wings more or less clouded with brown
29.	Wings uniformly infuscated (New Jersey; Maryland)No. 32, johnsonii Aldrich.
	Wings with a large conspicuous cloud beyond the middle (Colorado).
	No. 47, partitus Melander and Brues.
	2101 21, pur vous accument man 22 acci
	Group C.
1	Cilia of the calypters pale
	Cilia of the calypters black
2	Costa considerably enlarged before the tip of first vein (Montana).
₽.	No. 7, viridis, new species.
	Costa not or but little enlarged at tip of first vein
3	Hypopygial lamellae blackish (Colorado; Idaho; Washington; Nevada).
υ.	No. 9, nigricauda, new species.
	Hypopygial lamellae whitish with a black border
4	All joints of middle tarsi slightly compressed (Idaho; Nevada; Utah; California).
7.	No. 6, squamosus, new species.
	All joints of middle tarsi normal
Ę	Lamelise of the hypopygium somewhat quadrangular in outline (Colorado).
U.	No. 15, enigma Melander and Brues.
	Lamellae somewhat triangular in outline (California). No. 5, formosus, new species.
U.	Fifth joint of fore tarsi enlarged; second and third joints yellowish; hind femora
	ciliated (Hudson Bay Territory)
-	Fifth joint of fore tarsi plain
1.	
	Hind femora without cilia on the lower edge
ð.	Hypopygiai iameliae biackish (Eastern States)
^	Hypopygial lamellae whitish with a black border
y.	Fore tarsi over one and one-half times as long as their tibiae (Kansas).
	No. 13, kansensis Aldrich.
	Fore tarsi not over one and one-fourth times as long as their tibiae
10.	Middle and hind femora each with two preapical bristles, placed one before
	the other; face brownish (Colorado; Idaho; Nevada).
	No. 16, adaequatus, new species
	Middle and hind femora each with only one preapical bristle
11.	Face rather wide; costs with a small knotlike enlargement at tip of first vein
	(Colorado)
	Face narrow; costa without any enlargement at the tip of first vein (western).
	No. 11, myosota Osten Sacken.

12.	Hind basitarsi with ten or twelve large bristles (California; Colorado).
	No. 12 multisetosus, new species.
	Hind basitarsi with only two to six large bristles
13.	Hypopygial lamellae brown or brownish
	Hypopygial lamellae white with a black border
14.	Face narrow, silvery white (Illinois) No. 1, calainus Melander and Brues
	Face very wide, whitish; hypopygium and their lamellae rather small (Idaho).
	No. 4, sordidatus, new species.
15 .	Lamellae of the hypopygium acutely pointed at tip (Eastern States).
	No. 24, acuminatus Loew
	Lamellae not acutely pointed at tip
16.	Hypopygial lamellae large, rather subquadrate in outline (Colorado).
	No. 15, enigma Melander and Brues
	Hypopygial lamellae shaped otherwise
17	Lameliae of the hypopygium oval
11.	Hypopygial lamellae somwehat triangular in outline
10	Lamellae small and cut off rather straight at apex; fore tarsi wholly black
10.	
	(western)
10	Lamellae of moderate size, more rounded at apex
19.	Hypopygial lamellae not at all jagged at apex (California).
	No. 5, formosus, new species Lamellae jagged on apical margin
	Lameliae jagged on apical margin
20.	Fore tarsi scarcely as long as their tibae, slightly yellow at base; second, third,
	and fourth joints of nearly equal length (New York; Wisconsin; Idaho).
	No. 10, ovatus Loew
	Fore tarsi a little longer than their tibae, wholly black; second joint longer than
	third, and more than twice as long as fourth (Idaho).
	No. 8, nigrimanus, new species.
	Group D.
ı.	Costa greatly enlarged before the tip of first vein; middle tarsi very long and
	slender, each joint distinctly enlarged at tip; face reaching below the eyes
	(Nevada; Utah)
	Not with the above combination of characters 2.
2.	Cilia of the calypters pale
	Cilia of the calypters black
3.	Wings marked with black or brownish 4.
	Wings grayish hyaline, or only slightly clouded along the front 5
4.	Wings clouded with brown in front and along the veins; last three joints of
	hind tarsi fringed above (Puget Sound; N. Europe) No. 50, remipes Wahlberg.
	Apex of the wing with a conspicuous black or brown spot (Eastern States).
	No. 48, setiser Loew.
5.	Front covered with white pollen, which, viewed in certain directions, con-
•	ceals the ground color (Massachusetts) No. 28, agronomus Melander and Brues.
,	Front metallic, more or less shining.
R	First antennal joint unusually long and rather slender (Alaska).
υ.	No. 64, humilis, new species.
	· · · · · · · · · · · · · · · · · · ·
-	First antennal joint normal
	Hind tibiae distinctly thickened, mostly black
	Hind tibiae rather slender, yellow with black tips9.
8.	Middle and hind femora black at base, mostly yellow, the latter without
	cilia below, but with a fringe of long hairs on upper inner edge (Washington;

	All femora black, slightly yellowish at extreme base and tip; posterior pair ciliated below with long white hairs, without long hairs above (Washington).
	No. 31, melanderi, new species.
У.	Fore tarsi normal; third antennal joint nearly three times as long as wide;
	arista very short, subapical (Indiana)No. 40, angusticornis, new species,
	Fore tarsi with its joints narrowed at base; third antennal joint rather small,
	normal (Washington)
10.	Middle femora mostly yellow
	Middle femora largely or wholly black
11	Hind femora black
11.	
	Hind femora mostly yellow
12.	Last two joints of middle tarsi compressed and fringed (Alaska; Idaho; New
	Mexico; Utsh)
	All tarsi plain (Idaho)
13.	Hind femora wholly yellow (Colorado; Idaho; Nevada; Utah).
	No. 62, amnicola Melander and Brues.
	Triad formed black of the set least shows will a set with a black shows a
	Hind femora black at tip, at least above; middle ones with a black streak
	above or below
14.	Hind femora black above on whole upper edge 15.
	Hind femora black at tip (Labrador)
15	Costa with a knotlike enlargement at tip of first vein (Alaska).
	No. 60, solidus, new species.
	Costa not or scarcely at all enlarged at tip of first vein
16.	Hypopygium small, its lamellae yellowish; posterior femora without cilia below
	(New Hampshire)
	Hypopygium normal in size, its lamellae whitish; hind femora with a few white
	hairs below near the tip (New Hampshire; Colorado; Alaska)
	No. 44, xanthocnemus Loew.
١	Middle femora infuscated at base, gradually becoming yellow toward their
17.	
	apex
	Middle femora black, sometimes yellow at tip
18.	First antennal joint long and slender (Alaska)No. 64, humilis, new species.
	First antennal joint short as usual
10	Hypopygium short, its lamellae yellowish (New Hampshire)
10.	
	No. 65, brevicauda, new species.
	Hypopygium of normal size, its lamellae whitish
20.	Hind femora ciliated below near the tip with a few white hairs
	Hind femora without cilia below (Idaho)
21.	Cilia of the calypters black (New Hampshire; Colorado; Alaska).
	No. 44, xanthornemus, new species.
	Cilia of the calypters yellowish (Washington)No. 42, literalis, new species.
~~	
ZZ.	Hind femora ciliated with long hairs below
	Hind femora without cilia below, or with the cilia very short
23.	Hind femora ciliated with long black hairs
	Hind femora ciliated with pale hairs
24.	Wings with a conspicuous brown cloud in front, opposite the cross vein (Colorado.)
	No. 47, partitus Melander and Brues.
	Wings without a brown cloud (eastern)
ΩZ	Hind tibiae swollen, subfusiform, mostly black (South Dakota; Colorado;
Z 0.	
	Idaho; Wyoming)
	Hind tibiae slightly enlarged at tip, yellow with sharply defined black tips 26.
26.	Hind femora ciliated with a few long white hairs below; fore tarsi plain; costa
	with a small knot-like enlargement at tip of first vein (New Hampshire;
	Colorado; Alaska)
	Hind femora with short cilia below
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	Hind tibiae yellow with black tips (New York)No. 41, aequalis, new species. Hind tibiae mostly black (New York)No. 26½, burnest, new species.
28.	Distance between the third and fourth veins at tips only a little more than half as great as at the bend in the last section of fourth vein (Oregon; Washington) No. 35, convergens Aldrich.
	The third and fourth veins approach each other but little beyond the bend of fourth vein
29.	Hypopygial lamellae with very dense black hair on apical portion (Eastern Canada; North Dakota)
30.	Lamellae with only the usual fringe of bristles and hairs
	No. 26½, burnesi, new species. Costa not distinctly enlarged at tip of first vein; only one or two of the lower orbital cilia yellow; fore tarsi slightly compressed at tip (New York). No. 41, aequalis, new species.
	Group E.
1.	Arista ending in a lamella (New Hampshire)
2.	Anterior tarsi plain
3.	Anterior tibiae with a fringe of very long black hair on the front surface (Nevada). No. 84. barbines, new species.
4.	Anterior tibiae without such hair
5.	First two joints of the antennae yellow below, the first large (Vancouver Island; Puget Sound)
6.	Middle and hind femora ciliated below (Wisconsin; Europe)
7.	No. 83, ungulatus Linnaeus. Femora without cilia below (Alaska, Europe)
8.	Cilia of hind femora yellow; fifth joint of fore tarsi much longer than fourth (Hudson Bay Territory; Europe)
	Group F.
1.	Arista enlarged at tip (Labrador)
2.	Antennae black, the first and second joints may be yellow below
3	Fore coxae blackened at base for more than half their length, at least on outer surface 4.
	Fore coxae yellow, sometimes with a black or green stripe or spot on outer surface.
4.	Hind femora blackened at tip; fore tarsi plain (Puget Sound). No. 69, fucatus, new species.
	Hind femora wholly yellow; fore tarsi ornamented (widespread). No. 138, longiman us Loew.

5.	Hind tibiae blackened at tip 6.
	Hind tibiae wholly yellow or only slightly infuscated at tip 15.
6.	Last joint of fore tarsi more or less compressed
_	Last joint of fore tarsi plain
7.	First four joints of fore tarsi plain, fifth a very little compressed (Regina; Canada.)
	No. 94, canadensis, new species.
	Fourth and fifth joints of fore tarsi distinctly compressed
8.	Hind femora with long yellow cilia below (Alaska; Europe).
	No. 119, plumitarsis Fallen. Hind femora without cilia (Eastern States)
9.	Hind femora ciliated with long yellow hairs below
	Hind femora without cilis below
10.	Costa with a small knot-like enlargment at junction of first vein (Ontario).
	No. 104, flaviciliatus, new species.
	Costa a little enlarged at junction of first vein, gradually tapering to its tip (Maine;
	New York; Labrador)
11.	Last four joints of fore tarsi of nearly equal length, each a little narrowed at base
	(widespread)
	Second joint of fore tarsi distinctly longer than third; last four joints cylindrical,
	not narrowed at base
12.	Third antennal joint long, acutely pointed, arista nearly apical; hypopygial
	lamellae large (Massachusetts)
	Third antennal joint obtusely pointed or rounded at tip, arista inserted
	near the middle of the third joint; lamellae of moderate size, not large 13.
13.	Hind femora with a lower row of little black hairs on inner side, so that when
	seen from below there are two rows of little black hairs with a glabrous space
	between them on lower edge (eastern)
	Hind femora with the lower row of little hairs on inner surface yellow and
14	very delicate
17.	Fifth joint of fore tarsi yellowish; the yellow hairs on lower inner edge of
	hind femora nearly one fifth as long as the width of the femora; costa with- out an enlargement at tip of first vein; third antennal joint twice as long
	as wide
	Fifth joint of fore tarsi black, not at all paler than those preceding it; hairs on
	lower inner edge of hind femora very short; third antennal joint one and a
	fourth times as long as wide; costa with a small but distinct knot-like en-
	largement at tip of first vein (eastern). No. 90, socius, var. gladius, new variety.
15	Hind tarsi entirely black or very nearly so
	Hind tarsi yellow at base
	Hind femora without cilia below
	Hind femora ciliated on lower inner edge
	Fore tarsi twice as long as their tibiae, with last joint much compressed (Hudson
	Bay Territory)
	Fore tarsi one and one-fourth times as long as their tibiae, their last joint
	only slightly widened (Regina; Canada)No. 94, canadensis, new species.
18.	None of the joints of fore tarsi compressed, but the last four joints narrowed
•	at base (Maine; New York; Lahrador)
	Last joint of fore tarsi much compressed, lamelliform
	Enlarged last joint of fore tarsi with a white reflection on the outside (east-
	ern)
	The same without a white reflection
	Fore tarsi twice as long as their tibiae
	Fore tarsi one and a half times as long as their tibiae. 22.

21.	Antennae wholly black; cilia of hind femora rather scattering, extending nearly their whole length (Hudson Bay Territory)No. 139, subciliatus Loew. First antennal joint reddish or yellowish below; cilia of hind femora dense and confined to a short space on lower inner edge (Colorado). No. 140, amplipennis, new species.
22.	Costa with a small knot-like enlargement at tip of first vein (eastern). No. 142, splendidulus Loew.
	Costa with an elongated enlargement at tip of first vein (Eastern States). No. 141. splendidus Loew.
23.	Fore tarsi with the fifth joint compressed
	Fore tarsi dark yellow with fifth joint only a little compressed (Newfoundland)
25.	Fourth joint of fore tarsi distinctly less than half as long as fifth; hind tibiae considerably thickened in the middle (Eastern States). No. 189, batillifer Loew. Fourth joint of fore tarsi three fourths or more than three fourths as long as fifth
26.	Third joint of fore tarsi a little compressed, white; hind tibiae but little thickened (eastern)
27.	Hind femora not ciliated (eastern)
28.	Third and fourth joints of fore tarsi of equal length, fifth a little shorter, sometimes
	the last three joints are of nearly equal length (Eastern States). No. 185, eudactylus Loew.
	Third and fifth joints of equal length, fourth a little shorter (Indiana; Ontario). No. 186, versutus, new species.
	Second abdominal segment with a tuft of long yellow hairs on each side and a smaller and shorter one on each side of third segment (California; Utah; New Mexico)
30 .	First antennal joint long and thick, densely hairy on the outer side (Western States)
	First antennal joint normal; enlargement of the costa at tip of first vein as long as the cross-vein (Idaho; California; Oregon). No. 163, idahoensis, new species).
31.	Last joint of fore tarsi compressed (Illinois; New York; Wisconsin). No. 190, tener Loew.
	Fore tarsi plain 32.
32.	Hind femora without cilia below (Colorado)No. 178, celeripes, new species. Hind femora ciliated on lower inner edge
33.	The longest hairs that form the cilia on the hind femora not more then three-fourthe as long as the width of the femora; hind basitarsi mostly yellow (Virginia).
34.	No. 136, greenei, new species. The longest cilia on hind femora fully as long or longer than the width of the femora; hind basitarsi usually wholly black
	Group G.
1.	First antennal joint black, at least on upper edge. 2. First antennal joint wholly yellow. 43.

2	Hind femora blackened at tip, at least on upper surface 3
	Hind femora not at all blackened at tip
3.	. Middle tibiae with very long slender bristles, their basitarsi with a row of very
	long hairs; fore tarsi compressed (eastern)No. 79, comatus Loew
	Middle tibiae and basitarsi without unusually long bristles and hairs 4
4.	Fore tarsi with one or more joints compressed and dilated
	Fore tarsi plain
5.	Hind femora ciliated; fore tarsi with the fifth joint only slightly dilated, their
	basitarsi scarcely as long as second and third taken together (Alaska).
	No. 81, barycnemus Coquillett
	Hind femora without cilia; fore tarsi with the fifth joint conspicuously dilated
	their basitarsi nearly as long as the remaining four joints taken together (Massa
	chusetts; Maine; New Jersey)
6.	Fore coxae yellow, sometimes considerably blackened at base on outer surface. 7
	Fore coxae blackish almost to their tips
7.	Hind femora ciliated with long hairs on lower inner edge
	Hind femora without cilia
8.	Hind femora with one preapical bristle, their cilis long and delicate; anal angle of
	wing nearly obsolete (New Hampshire) No. 77, obsoletus, new species.
	Hind femora with two or three prespical bristles, their cilia stout, scarcely as
	long as the width of the femora; anal angle of wing prominent (Massachusetts
	New York; New Brunswick)
9.	Face ochraceous or grayish yellow; hypopygial lamellae about as long as wide
	(Wisconsin; Michigan)
	Face silvery white
10.	Hypopygial lamellae triangular with a sharp point at one corner, very narrowly
	bordered with black; wings wholly grayish (Maine; Newfoundland).
	No. 75, genualis, new species.
	Hypopygial lamellae oval, a little longer than wide, with black border; wings
	tinged with brown in front of third vein (New York; Illinois; Ontario.)
	No. 72, discolor, new species.
11.	Wings more or less clouded with brown
	Wings wholly grayish, or nearly so
12.	Apical portion of wing with a conspicuous blackish spot; fore femora not darker
	on upper surface (Illinois)
	Costal margin of wing brownish, darker in front of second vein; fore femora
	brownish on upper edge (Washington)
13.	Bend in last section of fourth vein small but not unusually so, third vein bent
	backward at tip (Eastern States)
	Last section of fourth vein only slightly bent, third vein only a very little bent
	back at tip (Eastern States)No. 74, sincerus, var. subdirectus, new variety.
14.	Front purple, blue or violet
	Front green or bronze colored
	Lest joint of fore tarsi compressed and dilated (Massachusetts; New Hampshire;
	New York)
	Fore tarsi plain
	Last section of fourth vein forked (widespread)No. 100, ramifer Loew.
	Last section of fourth vein only bent, without a stump
17.	Hind femora ciliate with very long pale hairs (Eastern States). No. 106, setosus Loew.
	Hind femora ciliated with black hairs
18	Antennae wholly black (widespread)No. 108, renidescens Melander and Brues.
	First two antennal joints yellow with a black line above (Eastern States).
	No. 110 marsing Allais

19.	Hypopygium short, with small yellowish lamellæ
20.	Antennae wholly black (New York)
,	First antennal joint conspicuously yellow below (Maine; Labrador).
	No. 97, abbreviatus, new species.
21	Hind femora ciliated on lower inner edge
۵1.	Hind femora without cilia
99	Fore tarsi ornamented
22.	
00	Fore tarsi plain
۵۰.	Fore coxae yellow (Alaska; Europe)
04	Fore toxae black
Z4.	Fifth joint of fore tarsi notched at tip so as to form two nearly equal lobes; first
	three joints slender, yellow (western)
	Fifth joint of fore tarsi divided into two unequal lobes, the upper one much the
	largest; first three joints slender, first yellow, other two white, all with black
	tips (California)
25.	Antennae wholly black; face yellowish
	First antennal joint distinctly yellow below
26.	Fore coxae with conspicuous black hairs on the anterior surface; third antennal
	joint a little longer than wide, rather rounded at tip (Ontario; Newfoundland;
	Massachusetts)
	Fore coxae with delicate yellow hairs on anterior surface; third antennal joint
	twice as long as wide, pointed at tip (Massachusetts; Maryland; Virginia;
	New York; Ontario)
27.	Cilia of hind femora short, about three-fourths as long as width of femora (New
	York; Indiana; Ontario)
	Cilia of hind femora as long or longer than the width of the femora
28.	Costa with a knotlike enlargement at junction of first vein; hypopygial lamellae
	about as long as wide, somewhat orbicular (Eastern States).
	No. 106, setosus Loew.
	Costa enlarged at junction of first vein, gradually tapering to its tip; lamellae
	distinctly longer than wide
29.	Middle basitarsi with a large bristle above; hypopygial lamellae oval, rounded
	at tip; fore tarsi with the joints normal (Illinois). No. 105, decorus, new species.
	Middle basitarsi without a bristle above; lamellae subquadrate, truncate at tip;
	second, third, and fourth joints of fore tarsi narrowed at base (Maine).
	No. 107, serratus, new species.
	Third antennal joint twice as long as wide (Ontario). No. 191, sicarius, new species.
	Third antennal joint not over one and one-half times as long as wide 31.
	Fore tarsi ornamented
	Fore tarsi plain
32 .	Fifth joint of fore tarsi scarcely compressed, small (Ontario).
	No. 94, canadensis, new species.
	Last joint of fore tarsi distinctly compressed and dilated
33.	Third joint of fore tarsi half as long as first (Vancouver Island; Idaho; Washing-
	ton)
	Third joint of fore tarsi one-fourth or less than one-fourth as long as first 34.
34.	Fourth and fifth joints forming an oval tip to the fore tarsi (Eastern States)
	No. 90, virga Coquillett.
	The oval tip to fore tarsi formed by the fifth joint only, which is equal to the
	third in length (California)
35.	Fore coxae partly or wholly black
	Fore coxae wholly yellow, or with a small blackish spot at base on outer sur-
	t

36.	Anterior coxae and basal part of fore femora black (western),
	No. 62, amnicola Melander and Brues.
	Fore coxae yellow with a large black or green stripe on outer posterior edge,
	which is wide above and pointed below
37.	Last four joints of middle tarsi a little compressed (Washington).
۲.,	No. 182, aldrichii Wheeler.
	All tarsi normal (widespread)
90	Middle tarsi wholly black (widespread)
JO.	
00	Middle basitarsi largely yellow
39.	Hind basitarsi yellow with black tip; hind margin of wing notched at end of
	fifth vein (North Carolina)
	Hind tarsi wholly black, at most slightly yellowish at extreme base 40.
40.	Fore tarsi black from the tip of the first joint (Illinois; Connecticut; New York).
	No. 96, defectus, new species.
	Fore tarsi with the first two, or last joint yellow, sometimes wholly yellow 41.
41.	Arista nearly apical; hypopygial lamellae large, twice as long as wide (Massachu-
	setts)
	Arista inserted near the middle of third antennal joint; lamellae moderately
	small, one and one-half times as long as wide
42.	Hypopygial lamellae rather small, with about six rather stout hairs on upper edge;
	fore tarsi wholly yellow (New York; Vermont)No. 93, idoneus, new species.
	Hypopygial lamellae moderately large, without hairs on upper edge, except
	those on rounded apical edge; last three joints of fore tarsi black (Ontario;
	Regina; Wyoming)
49	Arista enlarged at tip; wing with a lobe at tip of sixth vein
70.	Arista plain
	Hypopygial lamellae large; hind margin of wing with a deep sinus before the lobe
44.	
	(Washington)
	Hypopygial lamellae small; hind margin of the wing normal, except for the
	lobe at anal angle (California)
45.	Fore tarsi ornamented
	Fore tarsi plain
46 .	Front and dorsum of thorax thickly pollinose; bend in last section of fourth vein
	furnished with a stump (widespread)
	Front shining; last section of fourth vein only bent, without a stump 47.
47.	Third antennal joint wholly black
	Third antennal joint largely yellow 50.
48 .	Fifth joint of fore tarsi large, nearly orbicular, twice as long as third and fourth
	taken together (eastern)
	Fifth joint of fore tarsi moderately large, as long or a little longer than third and
	fourth joints taken together
49.	Fore tarsi infuscated almost to their base, second joint about half as long as first,
	third and fourth joints together nearly as long as fifth; hind tibiae narrowly
	but sharply blackattip (Colorado; New Mexico) No. 149, speciosus, new species.
	Fore tarsi with the first two joints yellow, second three-fourths as long as first,
	third and fourth taken together three-fourths as long as fifth; hind tibiae black-
	ened for more than one-third their length, the black shading into the yellow
	(Montana; Colorado; Utah)
50	Front green; hind tibiae black at tip, gradually becoming yellow, still largely
ω.	infuscated; fore tarsi with the fifth joint scarcely dilated (New York).
	No. 112, abrasus, new species.
	Front violet; fore tarsi with fifth joint considerably dilated; hind tibiae narrowly
	Front violet; fore tarsi with nith joint considerably dilated; hind tiblae harrowly

51.	Hind tibiae scarcely blackened on outer side, but distinctly so on inner surface; fore tibiae slightly infuscated at tip, and with a few flattened bristles (eastern)
	Hind tibiae sharply black at tip for one-fifth their length or more; fore tibiae wholly yellow and with their hairs and bristles normal (Eastern States).
59	No. 124, vigilans Aldrich. Middle basitarsi laterally fringed (widespread)No. 128, plumipes Scopoli.
02.	Middle basitarsi plain
53.	Hind femora ciliated below with long black hairs; front usually blue or violet 54.
ш.	Hind femora without cilia below; front green
54.	Last section of fourth vein bent at a right angle, and with a stump-vein at pos-
• ••	terior bend; hypopygial lamellae somewhat triangular, fringed with rather short
	hairs (Eastern States, from New York to Florida; Kansas).
	No. 114, reflectus Aldrich.
	Last section of fourth vein moderately bent, without a stump-vein; lamellae
	somewhat orbicular, fringed with very long hairs (eastern).
	No. 113, marginatus Aldrich.
55.	Antennae yellow, blackened at tip of third joint; hind tibiae mostly blackish, the black shading into yellow at their base (New York).
	No. 112, abrasus, new species.
	Third antennal joint wholly black; hind tibiae only slightly infuscated at tip (New Mexico)
	Group H.
1.	First antennal joint wholly yellow
	Antennae black, first joint sometimes yellow below, at least narrowly so 24.
2.	Arista enlarged at tip; wings with a conspicuous lobe at tip of sixth vein 3.
	Arista plain4.
3.	Hypopygial lamellae large; hind margin of wing with a deep sinus before the lobe (Washington)
	Lamellae small; hind margin of wing nearly normal, except for the lobe at tip of
	sixth vein (California)
4.	Fore tarsi ornamented
_	Fore tarsi plain
ъ.	Hind femora ciliated below; fore tibiae slightly enlarged and a little blackened at tip (eastern)
	Not with the above combination of characters
R	Hind coxae yellow; front and dorsum of thorax pollinose, nearly opaque (wide-
υ.	spread; Mexico)
	Hind coxae more or less black at base; front and dorsum of thorax shining 7.
7	Wings with a projecting lobe at tip of sixth vein
	Wings without or with scarcely a trace of such a lobe
8.	Wings with the lobe at tip of sixth vein very prominent 9.
	Lobe at tip of sixth vein small
9.	Hypopygial lamellae with the apical margin evenly rounded; costs not enlarged
	at junction of first vein (widespread)
	Apical margin of lamellae emarginate; costa enlarged at junction of first vein,
	tapering to the tip (widespread)
10.	First and second joints of fore tarsi of about equal length (Colorado; Wyoming). No. 152, <i>wratus</i> , new species.
	Second joint of fore tarsi distinctly shorter than first

11.	Third joint of fore tarsi more than half as long as second (Colorado).
	No. 154, coloradensis Aldrich
	Third joint of fore tarsi just about half as long as second (California).
	No. 151, completus, new species.
	Third joint of fore tarsi one-third as long as second (Wisconsin; Colorado).
	No. 157, amphericus Melander and Brues.
12.	Second joint of fore tarsi shorter, or at most scarcely longer than the two following
	joints taken together
	Second joint of fore tarsi distinctly longer than the two following joints taken
	together
13.	Second antennal joint yellow (Washington)No. 198, plumosus Aldrich.
	Second antennal joint black
14.	Third joint of fore tarsi yellow, fifth joint nearly as wide as long (Colorado;
	Idaho; Washington)
	Third joint of fore tarsi blackish, fifth about half as wide as long (Colorado; New
	Mexico)
15.	Third joint of fore tarsi infuscated at apex (Wisconsin).
-0.	No. 157, amphericus Melander and Brues.
	Third joint of fore tarsi wholly yellow
٠.	Third joint of fore tarst whonly yellow
10.	Third joint of fore tarsi more than half as long as second (Colorado).
	No. 154, coloradensis Aldrich.
	Third joint of fore tarsi scarcely half as long as second
17.	Second joint of fore tarsi two thirds as long as first (Colorado; Wisconsin).
	No. 157, amphericus Melander and Brues.
	Second joint of fore tarsi scarcely half as long as first (Idaho; Washington).
	No. 153, sufflavus, new species.
	Second joint of fore tarsi nearly or quite as long as first (Colorado; Wyoming).
	No. 152, æratus, new species.
18.	Middle basitarsi fringed with black hairs on both sides
	Middle basitarsi plain, not fringed
10	Middle tibiae nearly twice as long as their femora (Massachusetts; New Hamp-
10.	
	shire)
	Middle tibiae not over one and one-fourth times as long as their femora (wide-
	spread in U. S. and Europe)
20.	Hind femora ciliated with long black hairs; front violet (Eastern States).
	No. 113, marginatus Aldrich.
	Hind femora without, or with pale, cilia; front green
21.	Hind femora ciliated with long whitish hairs on lower inner edge (Eastern States).
	No. 134, oracilis Aldrich.
	Hind femora without cilis below
99	Hind margin of wing with a conspicuous sinus between the tips of fifth and sixth
<i></i>	veins (Eastern States)
00	Hind margin of wing normal, rather evenly rounded
23.	Hypopygium rudimentary, lamellae not developed; tips of hind tibiae wholly
	yellow (Illinois)
	Hypopygium normal, lamellae rather large; hind tibiae slightly infuscated at
	tip (New Mexico)
24.	Middle tarsi wholly deep black, the first joint thickened about as the hind basi-
	tarsi are (New Hampshire; Labrador)
	Middle basitarsi mostly yellow
25.	Fore tarsi ornamented
	Fore terminalin 98

26.	Hind femora ciliated on lower inner edge (Alaska; Europe).
	No. 119, plumitarsis Fallen Hind femora without cilia
~-	
27.	Front green or bronze colored
	Front violet
28.	Fifth joint of fore tarsi longer than fourth
	Fifth joint of fore tarsi shorter than fourth
29.	Fifth joint of fore tarsi only a little enlarged (Western States).
	No. 197, coquilletti Aldrich
	Enlargement of fifth joint of fore tarsi conspicuous
30.	First and second joints of fore tarsi of equal length
	Second joint of fore tarsi shorter than first
	Second joint of fore tarsi a little longer than first
31.	Third joint of fore tarsi one-fourth as long as second (Colorado; Wyoming).
	No. 152, gratus, new species
	Third joint of fore tarsi half or more than half as long as second (Rocky Mountain
	region). No. 150, procerus, new species
32.	Fore tarsi about one and three-fourths times as long as their tibiae (Oregon).
	No. 147, compactus, new species
	Fore tarsi about one and a fourth times as long as their tibiae
33.	Third joint of fore tarsi yellow; wing without an enlargement at tip of first vein
	(Colorado; Manitoba)
	Third joint of fore tarsi black; wings with a small but distinct enlargement at tig
	of first vein (New Mexico; Colorado)
34	Fore tarsi about one and two-thirds times as long as their tibiae; fore coxae with
01.	transverse, preapical, black line; scutellum slightly margined with yellow
	(Colorado)
	Fore tarsi scarcely one and one-half times as long as their tibiae, third joint one
	fourth as long as second; fore coxae without a black line; scutellum wholl;
	metallic green (Rocky Mountain region)No. 150, process, new species
95	Third joint of fore tarsi much longer than fourth (Massachusetts; Minnesota).
JU.	
	No. 146, angustatus Aldrich Third and fourth joints of fore tarsi of about equal length
0.0	
30.	First four joints of fore tarsi yellow (Alaska; New York; Canada; Europe). No. 144, discifer Stannius
02	First two joints of fore tarsi infuscated (Labrador)No. 145, boreus, new species
37.	Fifth joint of fore tarsi much longer than fourth (eastern).
	No. 117, porphyrops, new species
	Fifth joint of fore tarsi about one-fourth as long as fourth (New York; Alaska
•	Canada; Europe)
38.	Hind femora without cilia
	Hind femora ciliated on lower inner edge
39.	Middle tibiae with a row of extremely long bristles, their basitarsi also with
	row of very long hairs (widespread)
	Middle tibiae and basitarsi normal, without such bristles and hairs 40
4 0.	Tips of hind femora black; front violet (New Hampshire; Washington).
	No. 73, sincerus Melander
	Tips of hind femora not or scarcely infuscated; front green
41.	Second antennal joint wholly yellow; metallic color of mesonotum dulled with
	thick yellowish gray pollen (New Mexico)No. 111, dorsalis, new species
	Second antennal joint wholly black; mesonotum shining (Ontario; Regina; Wyo
	ming)
42.	Front green (New Jersey; New York; North Dakota)No. 101, incisuralis Loew

43 .	All coxae yellow, middle pair a little blackened on outer surface (Wisconsin).
	No. 132, flavicoza, new species.
	Middle and hind coxae black with yellow tips 44.
44.	Antennae wholly black (widespread)No. 108, renidescens Melander and Brues.
	First two joints of the antennae yellow; usually with a black line above (Eastern
	States). No. 113, marginatus Aldrich.
	Group I.
	стоир 1.
1	Antennae black, the first and second joints may be yellow below 2.
	First antennal joint wholly yellow
Z.	Antennse wholly black
	First antennal joint yellow below
3.	Front dark violet (California; New Mexico)
	Front blue green (eastern species)4.
4.	Wing with the anal angle prominent; fore coxae with black hairs on the anterior
	surface (Eastern States)
	Wing with the anal angle nearly obsolete; fore coxae with minute white hairs
	(Ontario)
_	
Э.	Third antennal joint twice as long as wide (Ontario).
	No. 191, sicarius, new species.
	Third antennal joint not much longer than wide, at most not over one and one-
	half times as long as wide
6.	Fore tarsi ornamented
	Fore tarsi plain14.
7.	Fifth joint of fore tarsi compressed and fringed above, sometimes with very minute
•	hairs8.
	Fifth joint of fore tarsi not or but little flattened, fringed laterally 13.
8.	Hind femora ciliated below; fore tarsi with the fourth joint white, fifth black
	(Pennsylvania; Ontario)
	Hind femora without cilia below 9.
9.	First and second joints of fore tarsi of equal length
	Second joint of fore tarsi not over two-thirds as long as first
10.	Fore tarsi with the third joint longer than the second (Western States).
	No. 206, canaliculatus Thomson.
	Fore tarsi with the third joint shorter than the second (Wyoming; Colorado.).
	No. 152, æratus, new species.
11	Fifth joint of fore tarsi only a little enlarged (Western States).
11.	
	No. 197, coquilletti Aldrich.
	Fifth joint of fore tarsi much compressed and dilated
12.	Fifth joint of fore tarsi only about one-fourth as long as fourth (widespread).
	No. 144, discifer Loew.
	Fifth joint of fore tarsi much longer than fourth (California.)
	No. 196, talus, new species.
13	Hypopygial lamellae incised into two lobes, so that the hyoppygium appears to
10.	have four lamellae (Eastern States)
• •	Lamellae not incised, thick and bare (Eastern States)No. 192, scoparius Loew.
14.	Hind femora with a single preapical bristle
	The usual preapical bristle ending a row of bristles of increasing length; outer
	posterior edge of fore coxae green
15 .	First antennal joint long and thick; cilia of the calypters unusually long (wide-
	spread)
	Antennae normal 16.
16	Front violet (Wyoming)
_0	Front green 17

17.	Wings with a large blackish spot at apex (Maine; Massachusetts; New Hampshire;
	New York; Pennsylvania)
	Wings with such a spot
18.	First antennal joint yellow with the upper edge black
	First antennal joint yellow on lower edge, at least nearly half black 20.
19.	Hind tibiae with a blackish spot at tip on inner side, on which the hairs are longer
	and denser than on other portions (North Carolina).
	No. 175, carolinensis, new species
	Hind tibiae wholly yellow, scarcely darker on inner side (Labrador).
	No. 169, latronis, new species.
20.	Face silvery white
	Face golden yellow, at least decidedly yellowish in color
21.	Anal angle of wing nearly obsolete (Ontario)No. 168, parvicornis, new species.
	Anal angle of wing rather prominent (Labrador)No. 169, latronis, new species.
22.	Anal angle of wing extending conspicuously toward the root of the wing; fore
	tarsi scarcely infuscated even at tip (Virginia).
	No. 172, virginiensis, new species.
	Anal angle of wing extending but little toward the root of the wing; all tarsi
	sharply black from the tip of the first joint (New Hampshire).
	No. 171, slossonae, new species.
23.	Last four joints of middle tarsi compressed (Western States).
	No. 182, aldrichii Wheeler. Middle tarsi plain as usual
24.	First antennal joint normal (Oregon; California). No. 164, cavatus, new species.
	First antennal joint long and with long bushy hair
25.	First two antennal joints broadly yellow below; lower 4-6 orbital cilia orange-
	yellow, the rest black (Western States)No. 160, consanguineus Wheeler.
	Antennae with the second joint wholly black or nearly so; lower half of the orbital
	cilia pale yellow (Western States)
26.	Fore tarsi ornamented
	Pore tarsi plain
27	Fore tarsi with the fifth joint only slightly enlarged; hind femora ciliated be-
	low
	Ornamentation of fore tarsi conspicuous
28	Fifth joint of fore tarsi wholly black, preceding joints yellow (Eastern States).
20.	No. 205, terminalis Loew.
	Fore tarsi infuscated from the tip of the first joint with the fifth joint pale yellow-
	ish except at base (New York; New Jersey)No. 180, domesticus, new species.
20	Hind femora ciliated below
20.	Hind femora without cilia. 38.
30	Hind coxae infuscated on basal half, at least with a large blackish spot on outer
υ.	surface
	Hind coxae wholly yellow or nearly so
21	First three joints of fore tarsi of nearly equal length, the third being a little the
JI.	longest (Western States)
	Second joint of fore tarsi longer than the first, third very much shorter 32.
20	
JZ.	Hypopygial lamellae truncate at apex, with a short, but rather acute point at
	upper corner (California; Oregon)
99	end (California)
	Humeri metallic
	Mumou moutilu

34.	Cilia of hind femora very short, not over one-fifth as long as the width of the femora (Louisiana; New Jersey)
35.	Cilia of hind femora at least half as long as the width of the femora
	No. 200, funditor Loew.
	Second joint of fore tarsi about equal in length to fourth and fifth joints taken together (Louisiana)
36.	Fore tarsi with the first four joints yellow, fifth black, compressed, but rather
	small (Eastern States)
	Fore tarsi with the two first joints yellow, third and fourth black, fifth white
	(New York; Minnesota)
	Fore tarsi with the first, second and basal half of third joint yellow, the remainder
	black; third and fourth joints fringed above with long black hairs 37.
3 7.	Cilia of hind femora distinctly longer than the width of the femora (widespread).
	No. 215, cuprinus Loew.
	Cilia of hind femora not half as long as the width of the femora (New York
••	Canada)
38.	Basal half of hind coxae blackish, at least on outer surface
30	Fore tarsi with the second joint nearly one-fourth longer than fifth
50.	Fore tarsi with the second joint as long as the first, or shorter
40.	Lamellae of the hypopygium scarcely twice as long as wide (Western States).
	No. 207, tenuipes Aldrich.
	Lamellae four times as long as wide (California) No. 211, superbus, new species.
41.	Fore tarsi with the first and second joints of nearly equal length 42.
	Fore tarsi with the second joint distinctly shorter than the first 43.
42 .	Third joint of fore tarsi longer than the second (Western States).
	No. 206, canaliculatus Thomson.
	Third joint much shorter than the second (Wyoming; Colorado).
	No. 152, <i>xratus</i> , new species.
43.	Hypopygial lamellae with a deep incision on upper edge (Western States). No. 209, duplicatus Aldrich.
	Hypopygial lamellae normal
44	Empodium large, white, forming a conspicuous white tip to the tarsi (Wash-
	ington)
	Empodium small, or at least not conspicuously large
4 5.	Wings with a small lobe at tip of sixth vein; costa not enlarged at junction of
	first vein; middle basitarsi with a large bristle above, hind basitarsi only a
	little yellow at base (California)
	Wings without such a lobe: costs with a long tapering enlargement; middle basi-
	tarsi without a bristle above; hind basitarsi yellow with the tip narrowly black
	(Western States)
46.	Tarsal ornamentation in the form of a fringe of long black hairs on upper edge of
	third and fourth joints of fore tarsi, none of the joints much compressed 47.
47	Fore tarsi with one or more compressed joints
T 1.	(widespread)
	Wings of ordinary form, rather evenly rounded behind (Illinois; Indiana;
	Ontario)
48 .	Last three joints of fore tarsi compressed, third white, fourth and fifth black with
	white tips (Kansas; Texas)
	Third joint of fore tarsi not compressed
49 .	Fifth joint of fore tarsi wholly white (Louisiana) No. 201, distinctus, new variety.
	Fifth joint of fore tarsi partly or wholly black 50.

50 .	Fifth joint of fore tarsi wholly black, rather small, with a finger-like appendage extending over the claws (Lousiana)
	dium large and white
51.	Fifth joint of fore tarsi with an appendage resembling a sixth joint, both tipped
	with white (District of Columbia; Louisiana; Illinois).
	No. 203, sexarticulatus Loew.
	Fourth and fifth joints of fore tarsi of about equal size, black; fifth joint with a white extension nearly as large as the joint itself, formed by the enlarged
	empodium (Texas)
52	Hind femora ciliated below; front in both species either green or violet 53.
02.	Hind femora without cilia. 54.
5 3.	Humeri more or less yellow; cilis of hind femora shorter than the width of the
	femora (widespread)
	Humeri metallic; cilia of hind femora longer than the width of the femora (New
	Jersey; New.York)
54.	Arista tipped with a lamella (Washington; Alaska)No. 109, hastatus Loew. Arista plain
55 .	Middle tarsi compressed and widened (widespread) No. 181, latipes Loew.
	Middle tarsi plain
56 .	Wings with a deep sinus between the tips of fifth and sixth veins 57.
	Wings normal in outline
57.	Wings with only a small incision at tip of fifth vein (Illinois; New Hampshire
	New York)
	Wings with a deep incision at tip of fifth vein, which causes a distinct lobe just
	basally of fifth vein (North Carolina)
58.	Costa not thickened at tip of first vein; face silvery (New York).
	No. 205, terminalis Loew. Costa a little thickened from the tip of first vein, tapering nearly to its tip; face
	yellow (Tennessee; Kansas)
	Costa with a conspicuous, elongated, knot-like enlargement at tip of first vein. 59.
59	Hypopygium very small, its lamellae not developed (Illinois).
00.	176, imperfectus, new species.
	Hypopygium and its lamellae normal (Eastern States)No. 177, vittatus Loew.
	FEMALES (Synopsis).
A 1.	All femora black, at least on basal half.
	B ¹ . All tibiae black
1	32. Anterior tibiae yellow and sometimes the others also.
	C ¹ . Inferior orbital cilia black.
	D¹. Fore tibiae yellow, middle mostly, hind ones wholly black 28.
	D ² . Four anterior tibiae yellow
	D ³ . All tibiae yellow, hind ones may be black at tip
	C ² . Inferior orbital cilia pale
A ³ .	Middle femora mainly yellow, anterior and posterior ones black on basal half
4 2	or more
	Anterior and middle femora yellow, posterior ones black
	Middle and posterior femora yellow, anterior ones largely black
	B ¹ . Orbital cilia wholly black
	B ² . Inferior orbital cilia pale.
•	C1. Cilia of the calypters pale.
	D ¹ . First antennal joint black at least above
	D ² . Antennae yellow, at least the first joint wholly yellow102.

	•
	C ² . Cilia of the calypters black.
	D ¹ . Tipe of hind tibiae black.
	E1. Tips of hind femora black, at least a little blackened above 107.
	E ² . Tips of hind femora wholly yellow
	D ² . Hind tibiae without a black tip, at most a little blackened on inner side at tip.
	E ¹ . Hind tarsi wholly black, or nearly so.
	F1. First antennal joint black, at least on upper edge
	F ² . First antennal joint wholly yellow
	E ² . Posterior basitarsi largely yellow.
	F ¹ . First antennal joint black, at least above
	F ² . First antennal joint wholly yellow.
	G1. Third antennal joint wholly black
	G ² . Third antennal joint yellow, at least at base
	FEMALES.
1.	Femora black, at least one pair mainly black
_	Femora yellow, the tips or extreme base may be blackened
2.	All femora and tibiae black, knees may be more or less yellow
	One or more pairs of tibiae, and sometimes also one or two pairs of femora
2	mainly yellow or yellowish
Э.	joints yellow with the upper edge blackNo. 33, appendiculatus, new species.
	Middle tarsi normal, their joints not noticeably enlarged at tip; antennae
	wholly black, or with the first joint slightly yellow below
4.	Middle and usually hind femora with two or three preapical bristles 5.
	Middle and hind femora each with only one preapical bristle 8.
5.	Lower orbital cilia black
	Lower orbital cilia pale
6.	Wings with a conspicuous brown apical spotNo. 23, argentipes, new species.
	Wings clouded along the veins and usually in front of the third vein,
7	No. 17, paluster Melander and Brues.
٠.	Third antennal joint nearly orbicular in outline, with the arista inserted at upper apical corner, and with a small notch below it; fore tarsi distinctly
	longer than their tibiae
	Third antennal joint a little longer than wide, the arista inserted at the middle
	of upper edge; fore tarsi scarcely longer than their tibiae,
	No. 16, adaequatus, new species.
8.	Cilia of the calypters pale, still they may appear blackish in certain lights 9.
	Cilia of the calypters black
9.	Rather large species with the tip of the fifth vein much bent and evanescent
	at tip, which is in a notch of the hind margin of the wing,
	No. 9, nigricauda, new species.
	Rather small species with the tip of the fifth vein gently arched, and nearly
10	reaching the wing margin, which is scarcely notched
10.	No. 6, squamosus, new species.
	White pollen of the face not extending above the antennae.
	No. 7, viridis, new species.
u.	Lower orbital cilia black
	Lower orbital cilia pale
12 .	Femora broadly yellow at tips; middle basitarsi with a bristle above.
	No. 19, manicula, new species.
	Femora wholly black, or nearly so

13.	Middle basitarsi without a large bristle above No. 2, monticola, new species.
	Middle basitarsi with a large bristle above
	Middle basitarsi mostly white or whitishNo. 22, stenhammari Zetterstedt.
	Middle basitarsi black
	Antennae and fore coxae wholly black
	First antennal joint yellow below; fore coxae usually conspicuously yellow on the
	whole inner side
16.	Hind margin of wing expanded a little just basally from the tip of the fifth vein,
	so as to form a slight sinus between this point and tip of sixth vein; all tarsi
	wholly black
	Hind margin of wing nearly evenly rounded
	Second and third joints of fore tarsi yellowish, first blackNo. 18, tetricus Loew.
	Fore tarsi wholly black, or black from the tip of the first joint
18.	Middle basitarsi decidedly yellow at base, sometimes mostly yellow (western
	species)
	Middle tarsi wholly black or nearly so
19.	Front, occiput, and thorax thickly covered with coarse yellowish pollen, which
	nearly conceals the ground color
	Front and thorax metallic as usual
20.	Wings with third and fourth veins decidedly convergent at tips.
	No. 10, ovatus Loew.
	Wings with third and fourth veins only slightly convergent.
	No. 24, acuminatus Loew.
21.	Middle basitarsi more or less yellow at base, usually considerably so; fore tibiae
	more or less tinged with yellow
	Middle basitarsi wholly black
22.	Bend in last section of fourth vein near its middle; fore tibiae and femora wholly
	black, or very nearly so
	Bend in last section of fourth vein considerably before its middle; fore femora
	and tibiae narrowly yellow at their tips
23.	Bend in last section of fourth vein about the length of the cross vein beyond that
	vein
	Bend in last section of fourth vein distinctly more than the length of the cross vein beyond that vein
04	
	One or two pairs of femora yellow on more than distal half
	Lower orbital cilia pale
	All tibiae black or blackish, except that the middle pair have a white or yellowish
	ring in the middle; their basitarsi mostly whitish. No. 22, stenhammari Zetterstedt. At least fore tibiae yellow
	At least fore tibies vellow 27
97	Fore tibiae yellowish; middle tibiae black with a yellowish ring occupying their
21.	middle third, sometimes only base and tip a little infuscated.
	No. 22, stenhammari Zetterstedt.
	Fore tibiae yellow; middle tibiae black, except that sometimes they are a little
	yellow at tip or at base along upper edge of basal half
	Four anterior tibiae yellow
	Middle and hind femora each with two preapical bristles
	Middle and hind femora each with one preapical bristle
29	Prespical bristles on middle and hind femora, one before the other, arranged
	longitudinally
	Prespical bristles one above the other or nearly so, arranged vertically 30.

30.	Middle basitarsi with a bristle above
	Middle basitarsi without a bristle above
31.	Middle basitarsi with a large bristle above (western)No. 20, corax Osten Sacken.
	Middle basitarsi without a bristle above
32.	Middle tibise with one bristle below; bend in last section of fourth vein not un-
	usually small
	Middle tibiae with more than one bristle oelow; bend in last section of fourth
	vein very small
99	Head with two yellow bristles on each side near the proboscis,
33.	
	No. 41, aequalis, new species.
•	Head without yellow bristles below
34.	Hind tibiae mostly or wholly black
	Hind tibiae largely yellow
35 .	Middle and hind femora each with two or three preapical bristles 36.
	Middle and hind femora each with one preapical bristle
36.	Middle and hind femora each with three preapical bristles.
	No. 47, partitus Melander and Barnes.
	Middle and hind femora each with two preapical bristles.
	37 -
37.	Front violet, or at least bluish
	Front green 40.
38	Fore and middle tarsi black from the tip of the first joint, sometimes brown almost
٠	to the base
	Fore and middle tarsi almost wholly yellow
20	Hind tibiae with the yellow on upper edge reaching their middle, or nearly so.
JJ.	No. 29, gratus Loew.
	Yellow on upper edge of hind tibiae reaching one-fourth or less than one-fourth
	renow on upper edge of find tibiae reaching one-lourth or less than one-lourth
	their length
40.	Hind tibiae almost wholly black, only a very little yellowish at extreme base;
	wings distinctly and rather uniformly brownish No. 32, johnsoni Aldrich.
	Yellow of hind tibiae extending along the upper edge for some distance at least;
	wings grayish, not tinged with brown
41.	Middle tarsi infuscated almost from their base; fore tarsi black from the tip of the
	first joint
	Fore and middle tarsi almost wholly yellow 42.
42.	Hind tibise with the yellow on their upper edge extending to their middle, or
	nearly so
	Yellow of hind tibiae reaching only to basal fourth or slightly more.
	No. 30, calcaratus Aldrich.
43 .	Fore tarsi black from the tip of the first joint, or wholly black 44.
	Fore tarsi only a little darkened at tip
44.	Hind femora with two preapical bristles; bristles on lower part of the head all
	black
	Hind femora each with one prespical bristle; head with two yellow or whitish
	bristles near the proboscis
45	Last section of fourth vein nearly straight, only a little bent.
70.	No. 41, aequalis, new species.
	Bend in last section of fourth vein small but quite abrupt.
40	No. 46, alacer, new species.
40.	Fore tibiae with two or three bristles on the lower anterior edge; bristles on lower
	part of the head all black
	Fore tibiae with only one small bristle below; head with two yellowish bristles
	below each side of the proboscis
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47.	Middle and hind femora each with three preapical bristles; middle tibiae with one bristle below, which is unusually long No. 47, partitus Melander & Brues
	Middle and hind femora each with one preapical bristle 48
48.	Hind tibiae wholly black, the extreme base may be yellow 49
	All tibiae yellow, at least at base on upper edge for a considerable distance; pos
40	terior pair black at tip
49.	Middle tibiae yellow; front covered with white pollen, which almost conceals the
	ground color
	Middle tibiae black with more or less yellow on upper edge, sometimes yellowish
	brown; front shining, metallic
50.	Third antennal joint large for a female, somewhat triangular, pointed, the arists
	inserted close to its tip
	Third antennal joint of normal size, if large the arista distinctly dorsal 51
51.	First antennal joint yellow below
	Antennae wholly black, or very nearly so
52	Middle tarsi wholly black (Alaska),
٠	Middle basitarsi largely yellow
53	Middle tarsi yellow with the tips of the joints broadly black, their anterior surface
ου.	with silvery pollen
	Middle tarsi black from the tip of the first joint
5.A	Wings with the third and fourth veins convergent toward their tips, where they
J4.	are scarcely more than half as far apart as at the bend in fourth vein.
	No. 35, convergens Aldrich.
	Third and fourth veins but little convergent beyond the bend in last section of
	fourth vein
==	
<i>5</i> 0.	Black at tip of posterior tibiae extending along the inner surface nearly or quite to their base
	Black at tip of posterior tibiae not extending up the inner surface to any great
	extent, usually not at all
56.	Small hairs on anterior surface of fore coxae wholly black or very nearly so.
	No. 45, albiciliatus Loew.
	Small hairs on fore coxae partly white, these white hairs conspicuous on outer
	half of the anterior surface
57.	Fore tarsi scarcely as long as their tibiae, fifth joint as long as third; orbital cilia
•••	silvery white
	Fore tarsi as long as their tibiae, third joint as long as fourth and fifth taken to-
	gether; orbital cilia white but tinged with yellow. No. 261, burnsil, new species.
5.0	Orbital cilia wholly black, except one or two near the proboscis
<i>.</i>	Many of the lower orbital cilia pale
50	Hind femora with short but distinct black cilia on lower inner edge.
Jō.	No. 45, albiciliatus Aldrich.
20	Hind femora without cilia on lower inner edge
OU.	Small species with the bend in last section of fourth vein distinctly before its
	middle
	· · · · · · · · · · · · · · · · · · ·
	its middle
51.	Last section of fourth vein only a little bentNo. 41, aequalis, new species.
	Last section of fourth vein with a small but rather sharp bend.
	No. 46, alacer, new species.
32.	Middle femora largely or wholly yellow, anterior and posterior ones black on
	basal half or more
	Anterior and middle femora yellow, posterior pair black
	Middle and posterior femora largely yellow, anterior ones black on basal half
	10

63	. Middle and hind femora each with two prespical bristles; hind tibiae black with
	their base yellow or yellow with tip and a stripe on inner side black.
	No. 54, remus, new species.
	Middle and hind femora each with one prespical bristle 64.
64.	Middle femora black at base, shading into yellow toward the tip 65.
	Middle femora mostly yellow on the sides, black at base and on lower edge as far
	as the middle or nearly so
65.	Small species, face silvery white, orbital cilia whitish. No. 44, xanthocnemus Loew.
	Rather large species; face gray; orbital cilia yellow. No. 51, sedulus, new species.
66.	Orbital cilia wholly black
	Lateral and inferior orbital cilia pale
67.	First antennal joint black above, yellow on lower half; lower orbital cilia yellow-
	ish
	ish
	No. 67, flavilacertus, new species.
68.	Lower orbital cilis and antennae wholly black; middle and hind femora each
	with two preapical bristles
	Lower orbital cilia pale
69.	First and second antennal joints broadly yellow below; the usual prespical
	bristle on hind femora ending a row of three or four bristles.
	No. 62, amnicola Melander and Brues.
	Antennae wholly black; hind femora with one preapical bristle 70.
70.	Hind tibise mostly yellow
	Hind tibise almost wholly black
71.	Orbital cilia wholly black
	Lower orbital cilia pale
72.	Fore coxee black or green, the tips may be yellow
	Fore coxae yellow, the outer side may be more or less black or green 75.
73.	First and second antennal joints yellow below
	Antennae wholly black
74.	Front violet
	Front green
75.	Middle basitarsi with a large bristle above
	Middle basitarsi without a bristle above
76.	Antennae wholly black
	First antennal joint yellow
77.	Posterior basitarsi with only one large bristle above; a small, very shining species.
	No. 84, barbipes, new species.
	Posterior basitarsi with more than one large bristle above
78.	Front thickly covered with brown pollen, nearly or quite concealing the
	ground color
	Front metallic, shining. 79.
79.	Antennae whoily black
	First and second antennal joints yellow below
80.	Hind tibiae black at tip for nearly or quite one-third their length.
	No. 85, brevipennis Meigen.
	Hind tibise black at tip for about one-fifth their length.
	No. 83, ungulatus Linnaeus.
	Hind tibise wholly yellow
81.	Orbital cilia wholly black
	Lower orbital cilis yellow with from one to six black bristles next to the
	proboscis
82.	Cilia of the calypters pale
	Cilia of the calypters black
	▼ ■

83.	Antennae black, the first and second joints may be yellow below
84.	Anterior coxae blackened at base for half their length or more, sometimes the
	yellow extends to the base on inner edge
	Anterior coxae yellow, at least on the front side
85.	Hind femora and tibiae each with a black tipNo. 69, fucatus, new species
F0.0	Hind femora wholly yellow
	87, omitted.] Hind tibiae black at tip for one-fourth their lengthNo. 116, pilatus, new species.
00.	Hind tibiae wholly yellow, their tarsi wholly black No. 138, longimanus Loew.
80	Hind tibiae distinctly blackened at tip90.
	Hind tibiae wholly yellow, or very nearly so
90.	Middle tibiae with three bristles below, two near apical third and one near basal
	third
	Middle tibiae with only one bristle below, placed near apical third (the cilia of the
	calypters are often more or less black in the three forms coming under this) 91.
91.	Fore coxae wholly yellow; last three joints of fore tarsi of equal length.
	No. 92, indigena, new species.
	Fore coxae with a small blackish spot at base on outer surface; third joint of fore
	tarsi longer than fourth, fifth equal to fourth
92.	Fifth joint of fore tarsi yellow or yellowish, paler than those preceding it.
	No. 89, socius Loew. Fifth joint of fore tarsi black
02	Anterior coxae with a green or blackish streak on posterior edge of outer surface.
yo.	No. 159, crenatus Osten Sacken.
	Anterior coxee wholly yellow or with a small blackish spot at base on outer
	surface
94.	Hind tarsi wholly black, or very nearly so
	Posterior basitarsi largely yellow
95.	First antennal joint yellow below
Ω£	Cross-vein long, nearly equaling in length the distance to the bend in last section
<i>5</i> 0.	of fourth vein, which is near its basal thirdNo. 188, palaestricus Loew.
	Cross-vein distinctly shorter than the distance to the bend in last section of fourth
	vein
97.	Bend in last section of fourth vein just before its middle.
	No. 141, splendidus Loew.
	Bend in last section of fourth vein at second fifth of its length.
	No. 142, splendidulus Loew.
	(The characters given as separating these three last species are unsatisfactory and
	probably uncertain.)
98.	Middle basitarsi without a bristle above
00	Middle basitarsi with a large bristle above near apical third
99.	Middle basitarsi with two bristles near basal third, the one on upper anterior edge may be a little the smallest
	Middle basitarsi with only one large bristle above
100	Antennae wholly black when viewed from aboveNo. 189, batilifer Loew.
	First antennal joint yellow on the lower edgeNo. 184, tonsus Loew.
101	. Face white
	Face slightly yellowish
	Face distinctly tinged with yellow
	(Characters given as separating these three species very unsatisfactory.)
102	2. Middle tarsi wholly deep black (Alaska)
	Middle basitarsi yellow, black at tip 103.

103.	Middle basitarsi with a large bristle above
	Middle basitarsi without a bristle above
104.	Middle tibiae with one bristle below; tips of all the joints of the fore tarsi black-
	ened
	Middle tibiae with one or more bristles below; fore tarsi mostly yellow. (We have
	no females of these species, but they would prob-¡No. 190, tener Loew.
	ably go in here)
105.	Tips of hind tibiae black
	Hind tibiae wholly yellow or nearly so, sometimes blackened at tip on inner
	side
106.	Tips of hind femora, at least a little blackened on upper edge 107.
	Hind femora wholly yellow
107.	Anterior coxae yellow, at most with a small blackish spot at base on outer sur-
	face
	Anterior coxae considerably blackened at base, sometimes mostly black, at least
	with a large black spot at base on outer side 109.
108.	Middle and hind femora each with one preapical bristle No. 79, comatus Loew.
	Middle and hind femora each with two or three preapical bristles.
	No. 78, trisetosus, new species.
109.	Anterior femora brownish on the upper edge (rarely this is faint).
	No. 71, affluens, new species. Fore femora not darker on upper edge110.
	Fore femora not darker on upper edge110.
110.	Last section of fourth vein nearly straight, with only a very small bend, which
	is close to its middle
	Last section of fourth vein with a small but distinct bend, which is before its
	middle 111.
111.	First antennal joint yellow below
	Antennae wholly black
112.	Fore coxae almost wholly blackish
	Fore coxae with a rather large blackish spot on outer side 113.
113.	Tips of hind femora black for a distance equal to the length of the preapical
	bristle, the black extending to the lower edge or nearly so.
	No.75, genualis, new species.
	Tips of hind femora with a small black spot on upper edge. No. 80, virga Coquillett.
114.	Middle and hind tarsi wholly black
	Middle basitarsi largely yellow
115.	Antennae black with the lower part of the first joint yellow.
	No. 129, dasypodus Coquillett.
	Antennae yellow, third joint blackened on apical half.
	No. 130, uxorcula, new species.
	First two antennal joints yellow, third blackNo. 128, plumipes Scopoli.
116.	Antennae black, first and second joints sometimes yellow below 117.
	First antennal joint wholly yellow
117.	Front blue or violet, sometimes almost black
	Front green or bronze color
118.	Last section of fourth vein with a stump at its bend
	Last section of fourth vein only moderately bent, without a stump 120.
119.	Middle tibiae with one bristle below, placed near the middle of lower anterior
	edge; antennae mostly black
	Middle tibiae with three bristles below, two near apical, one near basal third;
	first two antennal joints yellow with a narrow black line above.
	No. 114, reflectus Aldrich.

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12 0.	Middle and hind femora each with two preapical bristles. No. 108, renidescens Melander and Brues.
	Middle and hind femora each with one preapical bristle
121.	Second antennal joint wholly blackNo. 117, porphyrops, new species.
	Second antennal joint yellow with the upper edge narrowly black 122.
122.	Hind tibiae black at tip for nearly one-fourth their length:
	No. 114, reflectus Aldrich.
	Hind tibiae only a little blackened at tipNo. 113, marginatus Aldrich.
123.	Fore coxae with a green or black stripe on outer posterior edge, which is wide
	above and tapers to a point near the tips of the coxae
	Fore coxae considerably blackened at base
	Fore coxae wholly yellow, except sometimes a blackish spot at base on outer
	surface
124.	Hind femora with a row of bristles of increasing size, ending in the usual pre-
	apical bristle
	Hind femora with only one preapical bristle No. 165, penicillatus, new name.
125.	Fore coaxe nearly half black
	Fore coxae mostly black; hind tibise black at tip for about one-fifth their length.
	No. 121, obcordatus Aldrich.
	(The female of poller Osten Sacken, No. 120, probably goes in here and is likely
	to differ from that of obcordatus in having the black at tip of hind tibise more
	extensive.)
126.	Antennae wholly black, or nearly so
	First antennal joint distinctly yellow below 128.
127.	Length about 3 mm.; dorsum of thorax bronze brown with brown pollen.
	No. 99, brunneus Aldrich.
	Length 4.5 mm.; dorsum of thorax metallic greenNo. 102, melanocerus Loew.
128.	Middle basitarsi with a conspicuous bristle above
	Middle basitarsi without a bristle above
129.	Middle tibiae with only one bristle belowNo. 117, porphyrops, new species.
	Middle tibiae with three bristles below, two near apical and one near basal
	third130.
130 .	Bristle on middle basitarsi rather small; third vein bent backward so as to
	approach fourth at tip
	Bristle on middle basitarsi large; tips of third and fourth veins not convergent, 131.
131.	Bend in last section of fourth vein distinctly before its middle (eastern species).
	No. 105, decorus, new species.
	Bend in last section of fourth vein very near its middle (N. Europe; Alaska).
	No. 119, plumitarsis Fallen.
132.	Middle tibiae with more than one bristle below
	Middle tibise with only one bristle below
133.	Middle tibiae with three bristles below, two at apical, one at basal third: fore
	tarsi black from the tip of the first joint No. 94, canadensis, new species.
	Middle tibiae with two bristles below, one near apical third and one near the
104	middle
134.	Fore tarsi yellow with the fifth joint black, or wholly yellow.
	No. 191, sicarius, new species.
105	Fore tarsi black from the tip of the first joint
135.	Fore tibiae with two large bristles below; rather large species with large bristles on the tibiae
	Fore tibiae with only small bristles below; rather small species
190	Fifth joint of fore tarsi yellowish, paler than those preceding it.
130.	No. 89, socius Loew.
	Fore tarsi black from the tip of the first joint
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137.	Fore coxae wholly yellow
	Anterior coxae with a blackish spot at base on outer surface.
	No. 101, incisuralis Loew.
138.	Third antennal joint wholly black
	Third antennal joint yellow, at least at base
139.	Second antennal joint more or less yellow, usually largely so.
	No. 125, flagellitenens Wheeler.
	Second antennal joint wholly black or nearly so140.
140.	Bend in last section of fourth vein at basal third; tips of third and fourth veins
	rather widely separated
	Bend in last section of fourth vein a little beyond basal third; tips of third and
	fourth veins rather close together
141.	Last section of fourth vein with a stump at the bend142.
	Last section of fourth vein only bent, without a stump
142	Front shining
1.2.	Front opaque with pollen
142	Tips of middle tibiae blackish
110.	Tips of middle tibise not at all infuscated
144	Front violet
177.	Front green. 146.
145	Middle basitarsi with a large bristle above
140.	
140	Middle basitarsi without a bristle above
140.	
	Bend in last section of fourth vein a little before its middle.
	No. 175, carolinensis, new species.
147.	Hind tarsi wholly black, or only a little yellowish at base
	Hind basitarsi considerably yellow at base, usually yellow with a black tip. 175.
148.	First antennal joint black, at least on upper edge149.
	First antennal joint wholly yellow
149.	Middle tarsi wholly black
	Middle basitarsi yellow with a black tip
150.	Front violet or blue
	Front green or bronze color
151.	Coxae yellow, middle pair more or less blackened on outer surface; middle
	basitarsi with a large bristle above
	Middle and hind coxae black with yellow tips, or with the outer surface largely
	black
152.	Middle and sometimes hind femora with two preapical bristles; antennae wholly
	black
	Middle and hind femora each with one preapical bristle; first antennal joint
150	yellow below
100.	• • •
	No. 113, marginatus Aldrich. Antennae wholly black
154	Fore tarsi yellow with the fifth joint more or less black, sometimes wholly yellow,
104.	shorter than fourth; third and fourth veins convergent at tips; middle tibiae
	with one bristle below
	Fore tarsi black from the tip of the first joint, fourth and fifth joints of nearly
	equal length; third and fourth veins nearly parallel; middle tibiae with one
	bristle below
155	Middle basitarsi without a bristle above
100.	Middle basitarsi with a large bristle above
156	Fore tarsi yellow, usually with the fifth joint black, fifth joint shorter than fourth;
_50.	third and fourth veins convergent
	Fore tarsi black from the tip of the first joint, still the fifth joint yellowish.
	No. 89, socius Loew.
	110. 00, accius Local.

	Middle basitarsi wholly black
108.	First, second and part of third antennal joints yellow.
159.	No. 130, uxorcula, new species. Last section of fourth vein bent near its middle.
	No. 148, walkeri, new species. Last section of fourth vein bent a considerable distance before its middle.
	No. 150, procerus, new species.
160.	Front blue or violet
161	Front green or bronze
	Second anternnal joint partly or wholly yellow
162.	Second joint of middle tarsi a little longer than the firstNo. 127 pugil Loew.
	Second joint of middle tarsi about half as long as the first
163.	Middle basitarsi without a bristle above
	Middle basitarsi with a large bristle above, a little beyond its middle; small species
164.	Third antennal joint wholly black
	Third anternnal joint partly or wholly yellow
16 5.	Second antennal joint wholly black
	Second antennal joint yellow, at least on inner side
166.	Hairs on fore coxae mostly yellow and rather long
	face
167.	Hairs on inner edge of fore coxae and those near the tip black, also a cluster of
	longer black hairs at base on inner edge
	Hairs on fore coxae almost wholly yellowNo. 156, omnivagus, new species.
1 6 8.	First joint of fore tarsi not or but slightly longer than the two following joints
	taken together
	gether
169.	Tip of third vein considerably bent backward; fifth joint of fore tarsi distinctly
	longer than fourth
	Tip of third vein bent backward a little; fifth joint of fore tarsi scarcely longer
170	than fourth
170.	another rather large bristle near it on upper anterior edge.
	No. 152, æratus, new species.
	Large bristle on middle basitarsi placed before apical third, without another
	bristle near it
171.	Middle basitarsi without a bristle above
179	Middle basitarsi with a large bristle above
112.	small, but distinct lobe or expansion at tip of sixth vein. No. 155, lobatus Loew.
	Fore coxae with black hairs, and with scarcely a trace of an expansion at tip
	of sixth vein
173.	Front and dorsum of thorax opaque with pollen; last section of fourth vein with
	a stump at the bend
	Front and thorax shining, metallic; last section of fourth vein without a stump at its bend
174.	Face wide, yellowish, or grayish white
	Face silvery white, not very wide for a female No. 134, gracilis Aldrich.

175.	First antennal joint black, at least on upper edge
176.	Fore coxae yellow with a green or blackish stripe on outer posterior edge, which
	is wide above, usually tapering to a point below
177	Fore coxae wholly yellow, or blackened a little at base
177.	Hind femora with only one preapical bristleNo. 165, penicillatus, new name. The main preapical bristle ending a row of increasing size178.
178	One or more of the orbital cilia next to the proboscis black, above these are from
170.	four to ten orange colored cilia, the rest all black.
	No. 160, consanguineus Wheeler.
	Lateral and inferior orbital cilia all yellowish
179.	First antennal joint long and with long bushy hair; first and second joints broadly
	yellow on inner side below; arista thickened No. 169, crenatus Osten Sacken.
	First antennal joint and arista nearly normal
180.	Second as well as first antennal joint conspicuously yellow below181.
	Second antennal joint wholly black or only a little yellow on inner side182.
181.	Bend in last section of fourth vein very near basal third; third vein considerably
	bent backward at tip
	Bend in last section of fourth vein a little nearer the middle, because the portion
	beyond the bend is shorter; third vein not bent backward quite so much at
100	tip
102.	of that vein; rather large species
	Bend in last section of fourth vein distinctly further from the cross-vein than the
	length of that vein; rather small species
183.	Antennae wholly black; middle femora with two preapical bristles.
	No. 173. bakeri Cole.
	First antennal joint yellow below
184.	Middle basitarsi without a bristle above185.
	Middle basitarsi with a bristle above187.
185.	Fore tarsi yellow with the fifth joint black
	Fore tarsi black from the tip of the first joint
	Middle tibiae with one bristle below
	Middle tibiae with a row of three (sometimes only two) bristles on lower anterior
107	edge
167.	Inferior orbital cilia with a prominent black bristle near the proboscis188. No black bristle on the lower part of the head near the proboscis189.
188	Fore coxae black at base on the outer surface
100.	Fore coxae wholly yellow, or nearly so
189	Fore tarsi yellow with the fifth joint black No. 194, laciniatus Coquillett.
200.	Fore tarsi infuscated from the tip of the first joint
190.	Fore basitarsi yellowish-brown, the black at tip not sharply defined, shading
	into the yellowish color
	Fore basitarsi yellow, the black at tip sharply defined, second joint usually a
	little yellowish at base
191.	Third antennal joint wholly black
	Third antennal joint yellow, at least at base
192.	Second antennal joint wholly black
	Second antennal joint mostly yellow
193.	Middle basitarsi without a bristle above
104	Middle basitarsi with a large bristle above
194.	Third vein distinctly bent backward at tipNo. 196, talus, new species.
	Third vein scarcely bent backward at tip, nearly straight.
	No. 197, coquilletti Aldrich.

195.	Anterior femora with a few long, delicate, black hairs above near their base. No. 198, plumosus Aldrich.
	Hairs on upper edge of fore femora at base scarcely longer than those on the remainder of the upper edge
196.	Hind margin of wing rather deeply notched at tip of fifth vein.
	No. 209, duplicatus Aldrich.
	Hind margin of wing not or but little notched at tip of fifth vein 197.
197.	Bend in last section a little beyond its basal thirdNo. 207, tenuipes Aldrich.
	Bend in last section of fourth vein a little before its middle.
	No. 206, canaliculatus Thomson.
198.	Hind coxae blackened on outer surface of basal half or more, at least with a
	large blackish spot covering most of basal half
	Hind coxae yellow, still the outer surface sometimes has blackish streaks of spots
199.	Middle basitarsi with a large bristle above
	Middle basitarsi without a bristle above
200.	Third vein bent backward a little so as to approach fourth at tip in an even
	curve
	Third vein less bent at tip, nearly or quite parallel with fourth at tip.
	No. 211, superbus, new species.
201.	Hind margin of wing deeply notched at tip of fifth vein 202.
	Hind margin of wing not or but little indented at tip of fifth vein 203.
202.	First antennal joint rather long for a female
	First antennal joint short, of the usual length for a female.
	No. 175, carolinensis, new species.
203.	Anterior tarsi yellowish with the fifth joint black
	Anterior tarsi more or less infuscated from the tip of the first joint 205
204.	Tip of third antennal joint black
	Antennae wholly yellow
205.	Middle tibise a little blackened at tip
	Middle tibiae wholly yellow, not infuscated at tip
206.	Front and thorax with thick yellowish pollen, western No. 207, tenuipes Aldrich.
	Front and thorax with thin grayish pollen, shining, eastern.
	No. 131, fulvipes Loew.
207.	Last section of fourth vein bent at an obtuse angle without a stump 208.
	Last section of fourth vein bent at a right angle or nearly so, with a stump a
	the bend; middle basitarsi with a large bristle above
208.	Middle basitarsi with a large bristle above
	Middle basitarsi without a bristle above
209.	Humeri more or less yellow, at least the lower edge yellow.
	No. 179, scapularis Loew.
	Humeri wholly metallic
210.	All tarsi yellow, the anterior pair may have the last joint a little darkened. No. 212, ruficornis Loew
	Hind tarsi more or less infuscated from the tip of the first joint, at least the tip of the joints darkened
211.	Fore tarsi black or infuscated from the tip of the first joint.
	No. 180, domesticus, new species
	Fore tarsi with the first joint wholly yellow, sometimes darkened from the base
	of the second joint
212.	Fore tarsi black or blackish from the middle of the third joint, the black being
	rather sharply defined
	Third joint of fore tarsi wholly vellow or vellowish.

213. Wings narrowed toward the root; anal angle prominent; hind margin of wing with a slight sinus between the anal angle and the tip of the sixth vein.

No. 213, longipennis Loew.

Hind margin of wing evenly rounded; wing not narrower at root.

No. 214, sarotes Loew.

214. Dorsum of thorax with yellowish gray pollen......No. 203, sexarticulatus Loew. Dorsum of thorax with only a little grayish white pollen.

No. 205, terminalis Loew.

- 217. Humeri yellow
 No. 200, funditor Loew.

 No. 201, distinctus, new variety.

 Humeri metallic
 218.

- 220. I have found no characters to separate the following species: No. 177, vittatus Loew; No. 215, cuprinus Loew; No. 216, absonus, new species; probably the female of sarotes Loew (No. 214) may sometimes have a stump at the bend in the last section of fourth vein, in which case it would also come in here.

No. 1. DOLICHOPUS CALAINUS Melander and Brues.

Dolichopus calainus MELANDER and BRUES, Biological Bull., vol. 1, 1900, p. 138.

Male.—Length, 5 mm.; of wing, 4 mm. Face narrow, silvery white, tinged a little with yellow above. Front blue-green, shining. Antennae wholly black; third joint somewhat orbicular in outline, scarcely pointed at tip. Lower orbital cilia whitish.

Thorax and scutellum dark blue, shining; pleurae green with white pollen. Abdomen shining green with black incisures, slight blue reflections and spots of white pollen on its sides. Hypopygium black with green reflections on basal portion; its lamellae (fig. 1) of moderate size, somewhat triangular or almost crescent shaped, broadly rounded on outer edge, brownish with black border at apex, jagged and bristly below at apex, otherwise the apical border is fringed with black hairs.

Coxae, legs and feet black; anterior coxae with white pollen on the front side and little black hairs. Middle and hind femora each with one preapical bristle, the latter ciliated on lower inner edge with black hairs, the longest of which are about as long as the width of the femora; knees scarcely yellow. Tarsi wholly black; anterior pair plain, but little if any longer than their tibiae, fourth joint shortest, third and fifth joints of somewhat equal length; middle basitarsus

without a bristle above. Calypters and halteres yellow, the former with black cilia.

Wings nearly hyaline; costa with a small knotlike enlargement at tip of first vein; hind margin of wing scarcely indented at tip of fifth vein; anal angle prominent.

Redescribed from the single type specimen in the American Museum in New York, taken at Chicago, Illinois, May 8, 1896.

No. 2. DOLICHOPUS MONTICOLA, new species.

Male.—Length, 4 mm.; of wing, 3.5 mm. Face of moderate width, ocher yellow above, becoming white below. Front green, shining. Antennae (fig. 2a) wholly black; third joint about as long as wide, somewhat orbicular in outline, still pointed at tip, proboscis and palpi black, orbital cilia wholly black.

Thorax green with blue or sometimes bronze reflections, a little dulled with brownish pollen, which is almost invisible when viewed from above; pleurae more black with gray pollen. Abdomen green with slight bronze reflections and narrow black incisures; the white pollen on its sides rather abundant. Hypopygium black, its lamellae of moderate size, somewhat triangular in outline, but rounded apically, whitish with broad black border, fringed with fine brown hairs on apical portion, a little jagged at lower corner.

Coxae, legs, and feet wholly black, the articulations of the femora and tibiae narrowly brownish yellow. Fore coxae covered with white pollen and little black hairs on their anterior surface. Middle and hind femora each with one preapical bristle, the latter not ciliate, but with very minute, delicate brown hairs on lower inner edge. Hind tibiae gradually thickened apically; the glabrous stripe on upper edge may be seen for nearly their whole length as a narrow shining line between the two rows of large bristles. Fore tarsi plain, not longer than their tibiae; the basitarsi nearly as long as the remaining four joints taken together; fourth joint slightly shorter than fifth, which is about as long as the third; middle and hind tarsi each a little longer than their tibiae. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 2) dark grayish, strongly tinged with brown in front of third vein, sometimes back to the fifth, except beyond the cross vein, where it is grayish; cross vein slightly bordered with brown; costa not enlarged at tip of first vein; last section of fourth vein bent just before its middle; hind margin of wing not indented at tip of fifth vein, evenly rounded, the anal angle being nearly obsolete.

Female.—Face broad, about half as wide as long; wings darker than in the male; otherwise about as in the male.

Described from 11 males and 9 females, taken on Mount Constitution, Washington, July 7-17, by J. M. Aldrich; and 1 male taken at

Bear Lake, British Columbia, July 20, by R. P. Currie, in the United States National Museum collection.

Type and allotype in the National Museum, from Mount Constitution, Washington.

Type.-Male, Cat. No. 22977, U.S.N.M.

No. 3. DOLICHOPUS BARBARICUS, new species.

Male.—Length, 4 mm.; of wing the same. Face rather wide, white a little tinged with brownish below the antennae. Front green, not very shining. Antennae (fig. 3a) wholly black; third joint small, nearly round, but a little flattened in outline at tip. Proboscis and palpi dark yellowish brown. Orbital cilia wholly black.

Thorax green with bronze reflections, not very shining. Pleurae more blackish, dulled with gray polten. Abdomen green with coppery reflections. Hypopygium black; its lamellae not very large, somewhat triangular in outline, but rounded on lower and apical edges, black, fringed on apical edge with black hairs, not or but little jagged on apical border.

Coxae, femora, tibiae and tarsi black, knees very slightly yellowish. Fore coxae with white pollen and black hairs on their anterior surface, these hairs longer than in many species. Middle and hind femora each with two preapical bristles, placed one before the other; the latter not ciliate, but with a row of delicate hairs on lower inner edge, which become longer toward the tip of the femora. Hind tibiae gradually a little thickened toward their tips, middle of their inner side yellowish and with very short hair. Fore tarsi a little longer than their tibiae; first joint nearly as long as the remaining four joints taken together; fifth joint fully as long as the fourth. Middle and hind tarsi each about one and a fourth times as long as their tibiae. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 3) grayish; costa scarcely enlarged at tip of first vein: last section of fourth vein bent near its basal third; hind margin of wing scarcely indented at tip of fifth vein, nearly evenly rounded, but the anal angle a little prominent.

Described from 2 males from Colorado.

Type in United States National Museum. Paratype in the Cornell University collection.

Type.—Male, Cat. No. 22978, U.S.N.M.

No. 4. DOLICHOPUS SORDIDATUS, new species.

Male.—Length 4.5 mm. Face very broad, its pollen grayish white, the black ground color showing through a little in the type specimen. Front green with blue reflections. Antennae wholly black; third joint a little longer than wide, obtusely pointed at tip; arista a little longer than the antennae, lower half of the orbital cilia pale.

Thorax dark green, slightly dulled with an almost invisible brown pollen; pleurae with grayish pollen. Abdomen dark green with a little white pollen along its sides. Hypopygium black, its lamellae (fig. 4a) yellowish at base, becoming black near their middle, somewhat triangular in outline, but rounded apically, scarcely jagged at upper corner, fringed on apical border with short, delicate, little hairs.

Legs wholly black. Fore coxae with black hairs on their anterior surface. Middle and hind femora each with one preapical bristle, the latter without cilia below. Hind tibiae only a little thickened, their bristles long. All tarsi a little longer than their tibiae; middle tibiae with a large bristle below; middle basitarsus without a bristle; fore tarsi plain, the first joint about as long as the three following taken together, the fifth joint appears to be a little yellowish. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 4) dark grayish; costa scarcely thickened at tip of fifth vein; last section of fourth vein bent a little before its middle; hind margin of wing not indented at tip of fifth vein, almost evenly rounded;

anal angle rounded but rather prominent.

Female.—Agrees with the male, except that the third antennal joint is a little shorter and the hind tibiae a little more slender. The face is nearly the same width as in the male and of the same sordid white color; wings as in the male.

Described from 1 pair taken by J. M. Aldrich in Idaho.

Type, a male taken at Oxford; allotype, a female taken at Soda Springs; both in the United States National Museum.

Type.—Male, Cat. No. 22979, U.S.N.M.

No. 5. DOLICHOPUS FORMOSUS, new species.

Male.—Length 4 mm.; of wing 3.5 mm. Face rather narrow, bright silvery white, a little narrowed below. Antennae wholly black; third joint not much longer than wide, somewhat rounded at tip, evenly rounded below; front shining green; lower orbital cilia silvery white.

Thorax dark shining green with blue reflections, or wholly blue; pleurae dulled with white pollen. Abdomen dark green with black incisures and a little white pollen along its sides. Hypopygium black; its lamellae (fig. 5a) of moderate size but rather long, somewhat triangular, tapering into the stem, but rounded at apex, whitish with a black border of moderate width, not at all jagged, fringed with delicate little hairs which are brown except on lower part of the stem.

Coxae, legs and feet wholly black; femora with green reflections; knees slightly yellowish. Fore coxae with black hairs on their front surface. Middle and hind femora each with one preapical bristle, the latter not ciliate below. Hind tibiae but little thickened. Fore

tarsi scarcely as long as their tibiae; second to fifth joints of about equal length and taken together a little longer than the first joint. Middle tarsi a little longer than their tibiae, their basitarsus without a bristle. Calypters yellow, their cilia black. Knobs of halteres yellow, their stems brown.

Wings (fig. 5) grayish; costa not thickened at tip of first vein; last section of fourth vein a little bent beyond its basal third; hind margin of wing scarcely indented at tip of fifth vein; wings narrowed toward their bases, with the anal angle scarcely at all developed, leaving the sixth vein close to the wing margin.

Described from 2 males taken at Three Rivers, California, received by J. M. Aldrich from C. F. Baker.

Type.--Male, Cat. No. 22980, U.S.N.M.

No. 6. DOLICHOPUS SQUAMOSUS, new species.

Male.—Length 3.5 mm.; of wing 3 mm. Face rather wide, reaching the lower corner of the eye, rounded below, its sides nearly parallel, silvery white. Front dark shining green, the silvery pollen of the face extending above the antennae along the inner orbits more than half way to the vertex, sometimes covering nearly the whole lower half of the front. Antennae wholly black; first joint rather long; third scarcely longer than wide, rounded at tip, oval in outline. The black orbital cilia descending to about the middle of the eye, the lower cilia being silvery white, flattened, scale-like.

Thorax dark shining green; pleurae scarcely dulled, still with a little almost invisible brownish gray pollen. Abdomen dark shining green, usually with coppery reflections on the apical portion; one specimen has blue reflections on the sides at base; I can not see any pollen on the abdomen. Hypopygium black; its lamellae rather large, somewhat triangular in outline, but broadly rounded on upper angle at apex, yellowish white with a black border, which is narrow on apical portion and wider on the rounded upper edge, jagged and bristly at apex, closely fringed above, sparsely below, with delicate hairs.

Coxae, legs and feet black; femora with slight green reflections; extreme tips of coxae and knees yellowish brown. Fore coxae with white pollen and very minute white hairs on anterior surface. Middle and hind femora each with one preapical bristle, the latter bare below, above with rather long hair. Hind tibiae very little stouter than the anterior pairs, without a glabrous stripe above. Fore tarsi plain, rather stout, scarcely longer than their tibiae; first joint as long as the three succeeding joints taken together; third and fifth joints of nearly equal length, fourth a little shorter, second only about one third as long as first. Middle tarsi (fig. 6a) one and a fourth times as long as their tibiae, a little compressed and widened, being widest

at second joint. Hind tarsi a little longer than their tibiae. Calypters, their cilia, and the halteres yellow.

Wings (fig. 6) grayish with a faint brown clouding from the costa to the third vein, and from the tip of first vein to tip of third, more distinct in some specimens than in others; costa not enlarged at tip of first vein; last section of fourth vein bent near its middle; hind margin of wing not indented at tip of fifth vein; anal angle of wing nearly obsolete, the wing being narrowed toward the root.

Female.—Agrees with the male in color, form of antennae, legs and wings, except that the middle tarsi are shorter and less flattened and the anal angle of wing a little more prominent. The face is a little wider and the lower orbital cilia are but little flattened.

Described from 12 males and 3 females. J. M. Aldrich took 3 males and 3 females at Hagerman, Idaho, July 1, 1900, and 7 males at Wells, Nevada, July 12, 1911. C. L. Fox took 1 male at Olancha, Inyo County, California. I took 1 male at Great Salt Lake, Utah, June 8, 1915.

Type.—Male, Cat. No. 22981, U.S.N.M., from Hagerman, Idaho.

No. 7. DOLICHOPUS VIRIDIS, new species.

Male.—Length 3.5 mm.; of wing the same. Face rather wide, long, rounded below, silvery white. Front dark shining green. Antennæ (fig. 7a) wholly black; third joint longer than wide, oval. Lower orbital cilia silvery white, the lowest ones much flattened; the black cilia not descending to the middle of the eye.

Thorax dark blue-green, sometimes almost black-green, very shining; pleurae dulled with a little gray pollen. Abdomen colored about like the thorax. Hypopygium black, its lamellae small, somewhat triangular in outline, whitish with a black apical border, which is widest at upper and lower corners, a little jagged at lower corner, fringed with delicate dark hairs.

Coxae, legs and feet black, extreme tips of coxae and knees a little yellowish. Fore coxae with white pollen. Middle and hind femora each with one preapical bristle, the latter not ciliate below. Hind tibiae only a little stouter than the others. Fore tarsi plain, about one and a fourth times as long as their tibiae; first joint as long as the following three taken together; second nearly half as long as first, fourth and fifth of nearly equal length; each joint of the tarsi a little narrowed at base. Middle tarsi only a little longer than their tibiae, their basitarsus without a bristle. Calypters and halteres yellow, the former with white cilia.

Wings (fig. 7) a little tinged with brown, sometimes much so on the costal edge and along the veins; costa much enlarged from the tip of the first vein two-thirds of the way to the root of the wing, filling in the angle between the costa and the first vein but not extending beyond its tip; last section of fourth vein bent at its middle; hind margin of wing not indented at tip of fifth vein; anal angle prominent.

Female.—Face a little wider, silvery white; orbital cilia yellowish white; the pollen of the face not extending above the antennae; thorax and abdomen very bright shining green with some coppery reflections on the latter; calypters with white pollen.

Described from 1 pair taken at Oxford, Idaho, by J. M. Aldrich, and 1 male taken at Bozeman, Montana, June 25, 1900, by E. Koch, at an elevation of 4,800 feet.

Type.—Male, Cat. No. 22982, U.S.N.M., from Oxford, Idaho.

The male of this form differs from squamosus in having the lamellae of the hypopygium very much smaller, the face a little wider and much shorter, and its pollen not extending above the antennae as in that species. The female of viridis differs from that of squamosus in having the silvery pollen of the face end at the antennae; in squamosus it extends widely and conspicuously along the orbits nearly to the vertex.

No. 8. DOLICHOPUS NIGRIMANUS, new species.

Male.—Length 3.75 mm.; of wing 3.25 mm. Face of moderate width, a little narrowed below, silvery white. Front dark green. Antennae wholly black; third joint small, about as long as wide, somewhat orbicular in outline but a little pointed at tip. Lateral and inferior orbital cilia white, about six of the upper cilia on each side black.

Thorax dark shining green; pleurae dulled with gray pollen.

Abdomen green with the hind margins of the segments black, sometimes there are coppery reflections before the black margins; the white pollen on its sides not abundant. Hypopygium black; its lamellae (fig. 8a) moderately large, somewhat triangular in outline, but rounded at tip, white with a rather narrow black border on the apical margin, which is jagged and bristly.

Coxae, legs, and feet black, knees only a little yellowish. Middle and hind femora each with one preapical bristle, the latter not ciliated below. Posterior tibiae thickened, especially toward their tips. Fore tarsi a little longer than their tibiae; first joint nearly as long as the remaining four joints taken together, second joint nearly as long as third and fourth taken together, the third being about two-thirds and the fourth one-third as long as the second. Middle tarsi a little longer than their tibiae, their basitarsus being without a bristle above. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 8) grayish, tinged with brown in front of third vein; costa not enlarged at tip of first vein; last section of fourth vein bent near its middle; third vein bent backward at tip; hind margin

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of wing scarcely indented at tip of fifth vein; anal angle not prominent, the wing being narrowed toward the root.

Female.—A female taken at the same time as one of the males has the face wider, silvery white; the extreme tip of the fore tibiae are yellow; the second and third joints of the fore tarsi are nearer of a length than in the male, still the second is a little the longest; wings grayish and a little wider; anal angle rounded and not at all prominent.

Described from 2 males and 1 female from Idaho; 1 pair were taken at Bovill, June 17, 1911; the other male at Moscow Mountain July 7, 1918. All 3 specimens were taken by A. L. Melander.

Type from Moscow Mountain; allotype from Bovill; both are in the collection of A. L. Melander.

No. 9. DOLICHOPUS NIGRICAUDA, new species.

Male.—Length 5 mm.; of wing 4-4.3 mm. Face nearly as wide as the front, silvery white, a little yellowish just below the antennae. Front shining green with blue or coppery reflections. Antennae wholly black; third joint small, about as long as wide, a little pointed at tip. Lower orbital cilia silvery white, the lower cilia flattened, scale-like, the black cilia reaching down to about the middle of the eye.

Thorax green with blue and bronze reflections, shining; pleurae a little dulled with white pollen.

Abdomen green with blue and bronze reflections, usually the apical segments more coppery, very bright and shining, no white pollen on its sides. Hypopygium black; its lamellae (fig. 9a) large, nearly as long as the hypopygium, the wide central portion a little longer than wide, somewhat orbicular, with the narrow stem at base and a narrow rounded projection at apex fringed with long blackish hairs, which are longest at tip of the projection.

Coxae, legs, and feet black, knees a very little yellowish. Fore coxae covered with silvery pollen and with a few minute white hairs on the anterior surface. Middle and hind femora each with one preapical bristle, the latter without cilia below. Hind tibiae a little thickened, the glabrous stripe on upper surface can be seen as a shining line between the rows of large bristles. Fore tarsi a little longer than their tibiae, plain, the first joint scarcely as long as the three following joints taken together. Middle tarsi one and a third and hind tarsi one and a half times as long as their tibiae. Calypters, their cilia and the halteres yellow.

Wings (fig. 9) grayish; costa scarcely enlarged at tip of first vein, but when viewed from in front it shows a little flattening of the costa with a little bristle-like point at outer end on the lower surface of wing; last section of fourth vein considerably bent at its middle;

hind margin of wing scarcely indented at tip of fifth vein and nearly evenly rounded, the anal angle not being much developed.

Female.—The above description is true of the female in all points outside of the hypopygium, except that the costa has no enlargement at tip of first vein and the hind tibiae are scarcely at all thickened, they are not very much so in the male. The face is the same width as in the male and has the same silvery pollen.

Described from 5 males and 12 females taken by J. M. Aldrich, Hazen, Nevada, July 13, both at shore of Soda Lakes and at freshwater seepage near by; Market Lake, Idaho, and Longmire's Springs, Mount Rainier, Washington, Aug. 2. There is 1 pair from Colorado in the United States National Museum, collector unknown.

Type and allotype from Colorado and in the United States National Museum.

Type.—Male, Cat. No. 22983, U.S.N.M.

No. 10. DOLICHOPUS OVATUS Loew.

Dolichopus ovatus, Loew, Neue Beitr., vol. 8, 1861, p. 13; Mon. of N. Amer. Diptera, pt. 2, 1864, p. 35.—Osten Sacken, Cat. of N. Amer. Diptera, 1878, p. 108.

Male.—Length 4 mm.; of wing the same. Face very narrow, silvery white. Front rather narrow, shining green. Antennae (fig. 10a) wholly black; third joint nearly orbicular in outline, a little pointed at tip, lateral and inferior orbital cilia white, the black cilia descending about one-third the eye height.

Thorax dark shining green with slight bronze reflections on the anterior edge of the dorsum; pleurae dulled with whitish pollen.

Abdomen green with coppery reflections. Hypopygium black; its lamellae (fig. 10) rather small, somewhat triangular in outline, but rounded on upper corner; white with a narrow black border on apical margin, jagged and bristly on the lower corner, otherwise the outer margin is fringed with little dark hairs.

Coxae, legs, and feet black; knees, tips of fore and middle coxae and extreme bases of fore and middle basitarsi yellowish. Fore coxae with white pollen and minute black hairs on the anterior surface. Middle and hind femora each with one preapical bristle, the latter without cilia below. Hind tibiae scarcely thicker than the others, the glabrous stripe on their upper surface can be seen as a shining line between the rows of large bristles. Fore tarsi scarcely as long as their tibiae, the first joint being as long as the remaining four taken together, third and fourth joints scarcely as long as broad. Middle and hind tarsi slightly longer than their tibiae. Calypters and halteres yellow, the former with black cilia.

Wings a little grayish; costa not thickened at tip of first vein; bend in last section of fourth vein just beyond its basal third; hind

margin of wing scarcely indented at tip of fifth vein, evenly rounded, the anal angle being nearly obsolete.

Female.—Face wider than in the male, still not very wide for a female, silvery white; middle tibiae with one bristle below and their basitarsi without a bristle above; the third and fourth veins are convergent as in the male.

Redescribed from 7 males from the following locations: Lake Mills, Wisconsin, Aug.; Big Stone, South Dakota, Aug. (Aldrich); Ithaca, New York, May 19; Lewiston, New York, Aug. 1; Fort Erie, Ontario, June 9 (Van Duzee). Osten Sacken reports it from Illinois. Type locality.—"Middle States."

No. 11. DOLICHOPUS MYOSOTA Osten Sacken.

Dolichopus myosota, OSTEN SACKEN, Biologia Centrali Americana, Diptera, vol. 1, 1887, p. 213.—MELANDER and BRUES, Biological Bulletin, vol. 1, 1900, p. 148.

Male.—Length 4 mm.; of wing 3.5 mm. Face very narrow, silvery white. Front dark but shining green. Antennae wholly black; third joint but little longer than wide, oval but rather pointed at tip, lower orbital cilia white, the lower ones a very little flattened, the black cilia descending nearly to the middle of the eye hight.

Thorax and abdomen dark shining green with blue reflections, sometimes also with a little bronze on the fore part of the dorsum; pleurae and sides of the abdomen dulled with white pollen. Hypopygium black; its lamellae (fig. 11a) small, triangular, rather truncate at apex, white with very narrow black border on apical margin, scarcely jagged at lower corner, fringed on apical margin with delicate hairs.

Coxae, legs and feet black, knees a very little yellowish. Fore coxae with white pollen and with little black hairs on inner half, and white hairs on outer half of their anterior surface. Middle and hind femora each with one preapical bristle; the latter with a row of dark hairs on lower inner edge, these hairs scarcely long enough to call cilia. All femora usually tinged with green. Posterior tibiae thickened, especially at tip, with rather long hair on inner side. Fore tarsi about equal to their tibiae in length, first joint about as long as the remaining four taken together. Middle and hind tarsi distinctly longer than their tibiae, middle basitarsus without a bristle above. Calypters and halteres yellow, the former with black cilia.

Wings slightly grayish (fig. 11) darker in front of second vein; costa not enlarged at tip of first vein; last section of fourth vein bent just before its middle; hind margin of wing scarcely indented at tip of fifth vein, evenly rounded, the anal angle being obsolete.

Female.—Face as wide as the front, its pollen white; third antenna joint not as long as wide; orbital cilia not at all flattened; hairs of

the fore coxae all black; hind femora without a row of hairs below; hind tibiae not thickened. It agrees with the male in color, the wing venation, and in the middle tibiae having one bristle below and middle basitarsi being without a bristle above.

Redescribed from 8 males and 14 females taken by J. M. Aldrich: Kendrick, Idaho, May 25; St. Anthony, Idaho, June 16; and Wells, Nevada, July 16; and 1 female from Rainier, Washington, Aug. 30, at an elevation of 5,000 feet. I took 3 females in San Diego County, California, on the edge of the desert, Apr. 15.

Type locality.—Northern Sonora, Mexico. Melander and Brues report it from California. Type in British Museum; the identification is from the description only.

The males of ovatus, acuminatus, myosota, and nigrimanus are very much alike but they differ in the formation of the lamellae of the hypopygium; myosota has the lamellae small and truncate at apex; ovatus and nigrimanus have them rounded at apex, those of the former are smaller and less rounded than those of the latter; acuminatus has the lamellae long and acutely pointed at tip.

The female of ovatus has the third and fourth veins more convergent than those of acuminatus, the fore tibiae and fore and middle basitarsi of the former are less yellowish, but the females of the two species are not easily separated. The females of myosota and nigrimanus differ from the two species mentioned above in having the legs and feet wholly deep black, except that the knees may be a very little yellowish. They differ from each other in that myosota has third and fourth veins nearly parallel beyond the bend in fourth vein, while in nigrimanus they are more convergent; the two last are western and the former two are eastern species. The female of adaequatus ought to be mentioned here as it is very much like those mentioned above, except that it has two bristles below on the middle tibiae.

No. 12. DOLICHOPUS MULTISETOSUS, new species.

Male.—Length 3.5-4.25 mm.; of wing 3.5-4 mm. Face rather wide, silvery white, narrowed a little below. Front shining green, sometimes with bronze reflections. Antennae wholly black, third joint nearly orbicular in outline, but the notch where the arista is inserted makes the tip somewhat pointed. Lower orbital cilia glistening white, those near the proboscis a little flattened, scale-like, the black cilia descend about one-fourth of the eye height.

Thorax dark shining green, sometimes with bronze reflections; pleurae black, dulled with gray pollen.

Abdomen green with black incisures and coppery reflections, especially on the apical segments. Hypopygium black; its lamellae (fig. 12a) moderately small, somewhat triangular in outline, but

with the outer edge rounded, whitish with rather wide black border on apical margin, where it is fringed with delicate dark hairs, a little jagged and bristly on lower corner.

Coxae, legs, and feet wholly black, fore coxae with white pollen and little black hairs on their anterior surface. Middle and hind femora each with one preapical bristle, the latter not ciliated below. Hind tibiae thickened toward their tips; the glabrous stripe on their upper surface can be seen as a shining line between the rows of bristles, which are rather large, about eight in each row. Fore tarsi nearly one and one-fourth times as long as their tibiae. First joint as long as the three following taken together. Middle tarsi one and a third times as long as their tibiae and hind tarsi one and a fourth times; posterior basitarsi with about 12 large bristles. Calypters and halteres yellow, the former with black cilia below and numerous pale hairs or cilia above.

Wings (fig. 12) grayish, tinged with brown in front of second vein, sometimes the brown tint extends to the third vein; costa not enlarged at tip of first vein; fourth vein with the last section considerably bent near its middle; hind margin of wing a little indented at tip of fifth vein; the anal angle but little developed, rounded.

Females.—Face wide as the front, grayish brown; hind basitarsi with only a few bristles as usual; otherwise as in the male Middle tibiae with one bristle below and their basitarsi with a large bristle above.

Described from several males and females. J. M. Aldrich took it at Tennessee Pass, Colorado, July 25; Johnson took it at Pine Lake, Southern California; and E. P. Van Duzee took it at Tahoe, California, June 24, and at Huntington Lake, Fresno County, California, July 5-14, at 7,000 feet elèvation.

Holotype and allotype in the National Museum, and taken at Tahoe, California.

Type —Male, Cat. No. 22984, U.S.N.M., from Colorado.

No. 13. DOLICHOPUS KANSENSIS Aldrich.

Dolichopus kansensis Aldrich, Kansas Univ. Quart., 1893, vol. 2, p. 8.

The original description is as follows:

Dark green, feet black, cilia of inferior orbit white, face wide. Face and lower part of the front yellow pollinose, remainder of front dark green. Antennae black, third joint only moderately large, with a short arista. Dorsum of thorax dark green, pleurae black with but little dust. Tegulae [calypters] yellow with black cilia, halteres yellow. Abdomen dark green, toward the tip more black-green. Hypopygium black, the lamellae rounded, whitish with a rather wide black border and small bristles. Legs from coxae to tarsi wholly black, at the knees with the faintest trace of red. Fore tarsi over one and one-half times the length of the tibiae, middle tarsi about one and one-fourth times. Hind tibiae incrassated; hind femora below with delicate blackish cilia of moderate length, wings almost hyaline; costa slightly thick-

ened; last segment of fourth vein as in the figure of Hygroceleuthus ciliatus. Length 4.2 mm.; of wing 3.8 mm.

One male, Kansas. Type in the University of Kansas.

Resembles D. ovatus, but has wider face, shorter and weaker cilia on hind femora, and the fore tarsi nearly twice as long.

Copy of original description; type not seen.

No. 14. DOLICHOPUS DETERSUS Loew.

Dolichopus detersus, LOEW, Cent., vol. 7, No. 79, 1866.—ALDRICH, Kansas Univ. Quart., vol. 2, 1893, p. 8.—Melander and Brues, Biological Bulletin, vol. 1, 1900, p. 148.

Male.—Length 4.5-5 mm.; of wing 4 mm. Face rather, wide, silvery white. Front shining green. Antennae wholly black; third joint almost orbicular in outline, but a little pointed at tip. Inferior orbital cilia white, the black cilia reaching nearly to the middle of the eye height.

Thorax bright green, shining but dark; pleurae a little dulled with gray pollen. Abdomen dark shining green with black incisures. Hypopygium black; its lamellae (fig. 14a) rather large, somewhat triangular in outline, but rounded on apical margin, blackish, fringed with little hairs, jagged and bristly at tip.

Coxae, legs, and feet black; knees a little yellowish; fore coxae with white pollen and little black hairs on anterior surface. Middle and hind femora each with one preapical bristle, the latter ciliate on lower inner edge with long black hairs, the longest of which are a little longer than the width of the femora. Posterior tibiae a little thickened, more so toward their tips; the glabrous stripe on upper surface wide, including the inner row of large bristles. Fore tarsi as long as their tibiae; the first joint being about as long as the remaining four joints taken together. Middle tarsi about as long as their tibiae, hind ones one and a fourth times as long as their tibiae. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 14) a little grayish; costa with a small knot-like enlargement at tip of first vein; last section of fourth vein bent before its middle; hind margin of wing scarcely indented at tip of fifth vein, but just before its tip the margin has a small lobe, which forms a shallow sinus between the tip of fifth and sixth veins; anal angle rather prominent.

Female.—Face wide, rather silvery; hind femora without cilia; hind tibiae not thickened; costa without enlargement. Middle tibiae with one bristle below and their basitarsi without a bristle above. The wing has a slight, but distinct, outward wave or lobe before the tip of fifth vein as in the male, but much less prominent.

Redescribed from 7 males and 11 females from the following locations: St. Anthony Park, Minnesota; Battle Creek, Michigan (Aldrich); Milwaukee, Wisconsin, June 28 (Wheeler); Buffalo, New

York, Aug. 8; Toronto, Ontario, July 3 (Van Duzee); Montreal, Quebec, Aug. 6.

Type locality.—Saratoga, New York. Aldrich reports it from Minnesota and South Dakota; Melander and Brues from Illinois.

Type.—In Museum of Comparative Zoology, Cambridge, Massachusetts; has been examined.

No. 15. DOLICHOPUS ENIGMA Melander and Brues.

Dolichopus enigma MELANDER and BRUES, Biol. Bull., vol. 1, 1900, p. 139, fig.

Male.—Length 4-5.2 mm.; of wing the same. Face rather broad but short, silvery white, appearing dark gray in most lights. Front shining green. Antennae (fig. 15b) wholly black; third joint a little longer than wide, somewhat conical in outline, scarcely pointed at tip. Lower orbital cilia white; the black cilia descending about one-third of the eye height.

Thorax shining green, sometimes with bronze reflections; pleurae a little dulled with gray pollen. Abdomen green with very slight bronze reflections. Hypopygium black; its lamellae (fig. 15a) moderately large, quadrangular in outline but the stem placed close to the lower corner, yellowish white with a black border, which is widest on apical margin, jagged and bristly at apex, its sides fringed with little hairs.

Coxae, legs, and feet black, the knees scarcely yellowish. Fore coxae with white pollen and minute black hairs on their anterior surface. Middle and hind femora each with one preapical bristle, the latter ciliate with pale hairs on lower inner edge of apical half, which are nearly as long as the width of femora (easily overlooked); hind tibiae only slightly thicker than the others, the glabrous stripe on upper edge can be seen as a shining line between the rows of large bristles. Fore and middle tarsi a little longer than their tibiae. Third and fifth joints of fore tarsi of nearly equal length, fourth a little shorter. Middle tibiae with one bristle below, their basitarsi without a bristle. Hind tarsi one and a fourth times as long as their tibiae. Calypters and halteres yellow, the former with black cilia, which appears more or less pale in certain lights, in the type specimen it is almost white.

Wings (fig. 15) grayish, a little darker in front; costa with a very small knot-like enlargement at tip of first vein; last section of fourth vein bent just beyond its basal third; hind margin of wing scarcely indented at tip of fifth vein; anal angle rounded, only a little prominent.

Redescribed from the 1 male type in the American Museum at New York, taken at North Park, Colorado, at 9,000 feet elevation in July; and 4 males taken by J. M. Aldrich, at Marshall Pass, Colorado, July 28, at 10,856 feet elevation.

No. 16. DOLICHOPUS ADABQUATUS, new species.

Male.—Length 4 mm.; of wing the same. Face wide, covered with dark brown pollen, which is coarse and somewhat yellow in some individuals. Front shining green. Antennae (fig. 16b) wholly black; third joint slightly longer than wide, oval, rounded at tip. Lower orbital cilia whitish; the black cilia descend about one-third of the eye height.

Thorax green, not very dark or bright, but shining and with blue or bronze reflections; pleurae dulled with white pollen. Abdomen shining green with coppery reflections, especially toward its apex, sometimes with blue reflections on the basal segments. Hypopygium black; its lamellae (fig. 16a) moderately large, somewhat triangular, white with rather wide black border on the rounded apical margin, which is jagged and bristly, their upper and lower edges fringed with delicate brown hairs.

Coxae, legs and feet wholly black. Fore coxae with conspicuous little black hairs and white pollen on the anterior surface. Middle and hind femora each with two preapical bristles, placed one before the other, the latter ciliated with brown hairs on lower inner edge of their center, the longest of these hairs about three-fourths as long as width of femora. Hind tibise thickened, upper side with the bristles in the usual two rows large, about six in each row, the glabrous stripe between them distinct and widely extending upon the inner side of tibia on its basal half, lower side with a row of bristlelike hairs of somewhat unequal length and ending in one large bristle a little distance before the tip. Fore tarsi about one and a fourth times as long as their tibiae, the first joint a little longer than the two succeeding joints taken together, fourth joint slightly shorter than the fifth. Middle tarsi one and a fourth, hind tarsi one and a third times as long as their tibiae. Calypters and halteres vellow, the former with black cilia.

Wings (fig. 16) grayish; costa not or scarcely enlarged at tip of first vein; last section of fourth vein a little bent at its middle; hind margin of wing a little indented at tip of fifth vein, evenly rounded, the anal angle being very little developed.

Female.—Face a little wider than in the male; hind femora not ciliate but with delicate little brown hairs on inner edge of apical half; hind tibiae not or scarcely thickened; front of wing a little brownish as far back as the third vein; otherwise about as in the male. The middle tibiae have one bristle below and their basitarsi are without a bristle above.

Described from 22 males and 9 females. J. M. Aldrich took 6 in Idaho, June 12-20; Baker took 1 in Colorado; I took 23 at Wells, Nevada, June 6, and 1 at Victor, Colorado, June 11, at 9,900 feet

elevation. I found it quite abundant on marshy ground at Wells, Nevada.

Holotype and allotype in the United States National Museum, and taken at Wells, Nevada.

Type.—Male, No. 22985, U. S. N. M.

No. 17. DOLICHOPUS PALUSTER Melander and Brues.

Dolichopus paluster Melander and Brues, Biol. Bull., vol. 1, 1900, p. 136, figs.

Male.—Length 5-5.5 mm.; of wing 4.5-5 mm. Face wide, only a little narrowed below, covered with brown or yellowish-brown pollen. Front green, sometimes with bronze reflections. Antennae (fig. 17a) wholly black; third joint a little longer than wide, somewhat oval in outline. Proboscis and palpi black with black hairs, orbital cilia wholly black.

Thorax green, with indications of two coppery lines on the dorsum and sometimes blue reflections; pleurae more black with whitish pollen. Abdomen green with bronze and sometimes blue reflections, with scarcely a trace of white pollen on its sides. Hypopygium black; its lamellae of moderate size, oval, whitish with a sharply defined black border which is widest on apical margin and very narrow on lower edge, jagged and bristly at lower apical corner, fringed above with rather long but delicate brown hairs. Coxae, legs and feet black. Fore coxae with white pollen and black hairs on their anterior surface. Middle and hind femora each with two preapical bristles, placed one before the other; posterior pair ciliated with black hairs on lower inner edge; these hairs are brown or even whitish in same individuals and about three-fourths as long as the width of the femora. Middle tibiae with a long bristle below and one longer than the others beyond the middle on upper surface, hind tibiae thickened, with the glabrous stripe on upper surface quite distinct but narrow. Fore tarsi a little longer than their tibiae, the joints of decreasing length but the fifth not shorter than the fourth; first joint nearly as long as the three following taken together. Middle tarsi a little longer than their tibiae. Hind tarsi one and a third times as long as their tibiae. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 17) gray, usually tinged with brown in front of the third or even back to the fourth vein, the veins often narrowly bordered with brown; costa with a very small enlargement at tip of first vein; last section of fourth vein moderately bent near its middle; hind margin of wing scarcely indented at tip of fifth vein; anal angle not prominent, but the wing rather wide at its middle.

Female.—Face as wide as the front; hind tibiae not thickened; hind femora with only very short, delicate hairs on lower inner edge;

wings more strongly tinged with brown; otherwise about as in the male. The middle basitarsi without a bristle above.

Redescribed from 12 males and 9 females. Pacific Grove, California, May 9 (J. M. Aldrich); Monterey, California, July 17, and Pine Lake, southern California (Johnson); Palo Alto, California, June 3 (M. C. V.); Hood River, Oregon, June 8 (Cole).

Type locality.—Monterey, California.

Type.—American Museum of Natural History; it has been examined.

No. 18, DOLIC HOPUS TETRICUS Loew.

Dolichopus tetricus LOEW, Mon. of N. Amer. Dipt., pt. 2, 1864, p. 33.

Male.—Length, 4.5 mm.; of wing, 4 mm. Face rather wide, a little narrowed below, yellowish gray. Front green. Antennae wholly black (Doctor Loew states that the third joint is "almost round, still with a sharp projection at tip." The third joint is now missing in the male type). Lateral and inferior orbital cilia yellowish white, a few of the upper cilia black.

Thorax and abdomen dark green, the latter with coppery reflections. Hypopygium black; its lamellae of moderate size, elliptical in outline, whitish with a black border on apical and upper margins, jagged and bristly at apex.

Coxae black, anterior pair with black hairs and a very little white pollen on their front surface; femora and tibiae black. Fore and middle femora with apical third, hind ones with apical fourth yellow. Middle and hind femora each with one preapical bristle, the latter ciliated for nearly their whole length on lower inner edge with blackish hairs, the longest of which are about as long as the width of the femora. All tibiae yellowish at extreme base; posterior pair distinctly but not greatly thickened, but a little more so at tip; when viewed in the right direction they appear a little narrowed in the middle. Fore tarsi (fig. 18) a little longer than their tibiae; their basitarsi black, except at extreme tip, which is yellowish, about as long as the two following joints taken together; second and third joints yellowish; fourth black, a little more than half as long as third, perhaps very slightly compressed but scarcely so; fifth joint black, compressed, about as long as third and nearly as wide at tip as long, somewhat obcordate. Middle tarsi about one and a fourth times as long as their tibiae, the first joint more than half as long as the tibiae and with a large bristle near apical fourth. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia.

Wings grayish; costa not at all enlarged at tip of first vein; last section of fourth vein considerably bent near its middle; third vein bent backward a little toward its tip; hind margin rather evenly rounded, not indented at tip of fifth vein; anal angle rather prominent.

Female.—Face wider and whiter than in the male; wing and antennae as in the male, the third joint of the latter being as described by Loew and rather large for a female; fore tarsi plain, fifth joint slightly longer than the fourth, the second and third joints yellowish as in the male; wings as in the male.

Redescribed from the type specimens, 1 male and 1 female from the Hudson Bay Territory.

Type.—In Museum of Comparative Zoology, Cambridge, Massachusetts.

No. 19. DOLICHOPUS MANICULA, new species.

Male.—Length, 4-5 mm.; of wing 4-4.25 mm. Face wide, ocher yellow or brownish, a little glistening, in one specimen more grayish. Front shining green with bronze reflections, sometimes altogether bronze colored. Antennae wholly black; third joint only a little longer than wide, somewhat acorn shaped with the arista inserted near the base. Proboscis and palpi black. Orbital cilia wholly black.

Thorax blackish green or bronze brown; dorsum dulled with almost invisible brown pollen; pleurae more black with gray pollen. Abdomen green with coppery reflections. Hypopygium black; its lamellae rather large, somewhat elliptical in outline, whitish or tinged with brown with wide black border which shades into the disk, jagged and bristly at lower apical corner, otherwise fringed with little crooked hairs on upper and apical margins.

Coxae black, sometimes their tips yellow; anterior pair with white pollen and delicate little pale hairs on the front surface and the usual black bristles at tip. Femora black with their tips conspicuously yellow. Middle and hind femora each with one preapical bristle, the latter ciliated on lower inner edge with stiff black hairs, which are scarcely as long as the width of the femora. Tibiae black; hind tibiae thickened, especially at tip. Fore tarsi (fig. 19a) one and a fourth times as long as their tibiae; first joint black with extreme base and tip yellow, about as long as the three following joints taken together; second and third joints wholly yellowish, third a little shorter than the second: fourth black, slightly compressed, about as long as wide, about three-fourths as long as third; fifth joint black, longer than third, considerably compressed, as wide as long, bilobed at apex, the two lobes subequal; tips of first four joints covered with grayish-yellow pollen, which gives them a grayish color in certain lights. Middle tarsi wholly black, one and a fourth times as long as their tibiae. Hind tarsi one and a third times as long as their tibiae, wholly black. Calypters and halteres yellow, the latter with black cilia.

Wings (fig. 19) a little tinged with blackish gray; costa not enlarged at tip of first vein; last section of fourth vein bent before its

middle; hind margin of wing not indented at tip of fifth vein, not much widened in the middle, the wing being of somewhat equal width; anal angle of wing rather prominent.

Female.—Face as wide as the front, grayish white, more yellowish above; fore tarsi plain, black; hind femora with a row of rather long hairs on lower edge, but these hairs scarcely long enough to be called cilia; wings a little wider and more rounded on posterior edge; otherwise about as in the male. The middle tibiae with one large bristle on lower side and their basitarsi with a large bristle above.

Described from 8 males and about 20 females taken by J. M. Aldrich in Colorado, Tennessee Pass, July 25-26, and Marshall Pass, July 28, at 10,856 feet elevation; 2 males in the United States National Museum from Beulah, New Mexico, top of Las Vegas Range, June 28; and 1 male taken at the northwest entrance to Yellowstone Park, Wyoming, Aug. 3, by A. L. Melander.

Type.—Male, Cat. No. 22986, U.S.N.M., from Marshall Pass.

This species differs from tetricus Loew in having the orbital cilia wholly black, while in tetricus they are pale yellowish, except a few black above. The form and color of the fore tarsi of the two species are nearly alike, still there is a slight difference, but they could not be separated by the tarsi alone. The difference in the color of the orbital cilia makes it impossible to place them under one species. The females differ in the color of the fore tarsi, which are wholly black in manicula, while the second and third joints are yellowish in the female of tetricus.

No. 20. DOLICHOPUS CORAX Osten Sacken.

Dolichopus corax OSTEN SACKEN, Western Diptera, 1877, p. 314.

Male.—Length 5 mm.; of wing 4.5 mm. Face rather wide, a little narrowed below, dark satiny yellow, almost golden yellow. Front green. Antennae black, third joint more brownish, not longer than wide, somewhat conical in outline, scarcely pointed at tip. Orbital cilia wholiy black.

Thorax dark green with yellowish pollen, which is almost invisible when viewed from above; pleurae with a little grayish pollen. Abdomen dark green. Hypopygium black; its lamellae moderately large, black, only a little yellowish at their base below, somewhat triangular in outline, but broadly rounded on apical margin, jagged and bristly at lower apical corner, otherwise fringed with little blackish hairs both above and below.

Coxae, legs, and feet black, fore tibiae becoming more or less yellowish toward their tips. Fore coxae covered with black hairs. Middle and hind femora each with one preapical bristle, the latter not ciliate; posterior tibiae thickened, their bristles strong, the usual

glabrous stripe on upper surface between the bristles narrow, inside of the inner row of bristles is another glabrous stripe extending their entire length. Fore tarsi (fig. 20) one and a third times as long as their tibiae; first joint longer than the three following joints taken together and second joint longer than the two following; fourth joint shorter than third and a little wider; fifth much compressed and about equal to the second in length, somewhat round in outline, but a little wider at tip where it is rather truncate, on the inner side the fifth joint can be seen running across the expanded part about its normal size, at tip the upper part extends over the claws a little. Middle basitarsi with a large bristle above near its apical third. Calypters and halteres yellow, the former with black cilia.

Wings grayish, rather strongly tinged with brown in front of third vein, of rather parallel width, costa not enlarged at tip of first vein; last section of fourth vein bent before its middle, tip of third vein bent backward a little at tip; hind margin of wing a little indented at tip of fifth vein, there is a quite conspicuous sinus between the tips of fifth and sixth veins, anal angle prominent.

Female.—Face wide, gray, tinged a little with yellow; fore tibiae a little yellowish as in the male, fore tarsi plain, fifth joint longer than fourth; middle basitarsi with a large bristle above; wing as in the male, except that there is no sinus on hind margin, the wing being more evenly rounded.

Redescribed from the type material taken at Webber Lake, California, July 24-26; now in Museum of Comparative Zoology, Cambridge, Massachusetts.

A female taken by Edward P. Van Duzee at Grass Lake, Tahoe, California, June 24, 1915, seems to belong here and agrees with the type specimens, except that the fore tibiae are wholly black, not at all yellowish. Another female agreeing with this one was taken by R. P. Currie, at Kokanee Mountains, British Columbia, Aug. 10, 1903, at an elevation of 8,000 feet.

No. 21. DOLICHOPUS ACRICOLA, new species.

Male.—Length 4 mm.; of wing 3.5 mm. Face rather wide, yellowish brown. Front dark shining green. Antennae black, first joint conspicuously yellow below; third joint rather small, not much longer than wide, rounded at tip. Palpi yellowish with black hairs. Orbital cilia wholly black.

Thorax dark green, slightly dulled with brown pollen. Abdomen and hypopygium dark green with bronze reflections; lamellae of the latter moderately large, somewhat elliptical in outline but narrowed into the stem, about twice as long as wide, dark yellowish brown with a black border on apical margin, jagged and bristly at apex, fringed on both edges with delicate brown hairs.

Coxae, legs, and feet black, knees only a little paler. Fore coxae yellow (in one specimen only slightly reddish) on inner edge, covered with conspicous black hairs on anterior surface. Middle and hind femora each with one preapical bristle, the latter not ciliated below. Posterior tibiae a little thickened, about five large bristles in each row on upper edge and a row of stiff hairs, in which are inserted five bristles of increasing length, below. Fore tarsi (fig. 21a) a little longer than their tibiae, the first four joints being equal to the tibiae in length; first joint as long as the three succeeding joints taken together, third a little shorter than the second, fourth slightly compressed, half as long as third, as wide as long; fifth compressed, scarcely as long as the second joint, somewhat oval in outline but widest near the tip, where it is rather truncate, but still a little rounded. Middle tarsi one and a fourth times as long as their tibiae, their basitarsi with a large bristle above at apical third. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 21) grayish, scarcely darker in front; costa slightly enlarged at tip of first vein; last section of fourth vein a little bent near its basal third, the distance of this bend from the cross-vein about equal to the length of that vein; third vein bent backward so as to approach the fourth at tip; hind margin of wing indented at tip of fifth vein and with a wide sinus between the fifth and sixth veins, so as to form a slight lobe back of fifth vein and another at tip of sixth vein; anal angle of wing prominent.

Female.—Face wider and more grayish brown than in the male; antennae and palpi about as in the male; the fore coxae seem to be altogether black and have the same rather long black hairs as the male; fore tarsi plain, still the fifth joint very slightly widened, as long as third, fourth distinctly shorter than third; middle tibiae with three bristles below their basitarsi, with a large bristle above.

Described from 3 males and 1 female, taken at Tuolumne Meadows, California, Aug. 8, 1916, at an elevation of 9,000 feet, and one male taken at Soda Springs, California, at 8,600 feet, by G. R. Pilate.

Type.—Male, Cat. No. 22987, U.S.N.M.

No. 22. DOLICHOPUS STENHAMMARI Zetterstedt.

Dolichopus stenhammari ZETTERSTEDT, Insecta Lapp., 1839, p. 710 (annulipes, preoc.); Diptera Scand., vol. 2, p. 521.—OSTEN SACKEN, Cat. N. Amer. Dipt., 1878, p. 108.—Coquillett, Proc. Wash. Acad. Sci., vol. 2, 1900, p. 424.—Aldrich, Cat. N. Amer. Diptera, 1905, p. 305.

Male.—Length 4.4-5 mm.; of wing 5-5.25 mm. Face wide with its sides nearly parallel, silvery white. Front dark green, somewhat dulled with brown pollen. Antennae wholly black; third joint a little longer than wide, somewhat pointed; arista a little

longer than the antenna, inserted at about the middle of the third joint. Orbital cilia wholly black, rather long except a few near the proboscis which are shorter.

Thorax blackish with green reflections and dulled with brown pollen on the dorsum, which leaves ill defined, shining vittae; pleurae with grayish pollen. Abdomen dark green with black incisures and spots of white pollen on the sides of the segments. Hypopygium black; its lamellae (fig. 22a) rather large, somewhat elliptical in outline but truncate at apex, not quite twice as long as wide, dark yellowish or brownish, shading into a broad apical border of a blackish color (sometimes the lamellae are of a more whitish color), jagged and bristly at apex.

Coxae, legs, and feet black, trochanters and knees yellow. Fore coxae with black hairs. Middle tibiae with the middle third white and with five bristles below, their basitarsi white, narrowly black at tip, the white portion with silvery pollen on its anterior surface. Middle and hind femora each with one preapical bristle, the latter ciliated with black hairs, the longest of which are longer than the width of the femora, those near the base much shorter. Posterior tibiae a little thickened near the base and at tip, a little more slender in the middle, their bristles long. Fore tarsi fully one and a half times as long as their tibiae, their joints of decreasing length, first joint nearly as long as the three succeeding joints taken together. Middle tarsi one and a fourth times as long as their tibiae. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 22) grayish; costa enlarged at tip of first vein, gradully tapering to its tip; last section of fourth vein a little bent near its middle, at this bend and on the cross-vein there is an almost imperceptible brown shade; hind margin of wing scarcely indented at tip of fifth vein; anal angle rounded.

Female.—Face wider than in the male; third antennal joint about as long as wide; fore and middle tarsi about one and a fourth times as long as their tibiae; white on middle tibiae and basitarsi usually more obscure; costa not enlarged at tip of first vein. Middle basitarsi with one bristle above and several smaller ones below; these are more prominent in the male.

Redescribed from several males and females from Alaska and Labrador: Sitka, Alaska, June 16, 1899, by T. Kincaid (Harriman Exped.); Caribou Island, Labrador, taken by Packard and in the Museum of Comparative Zoology in Cambridge, Massachusetts; Labrador, coll. of C. W. Johnson; Ungava Bay, Labrador, taken by L. M. Turner, on July 29; and one female Morrison took in the White Mountains, New Hampshire; all but the Packard material in the United States National Museum.

In some of the Labrador specimens the fore tibiae and basitarsi have the same white ring as the middle ones.

Type.—Believed to be in the University of Lund, Sweden.

No. 23. DOLICHOPUS ARGENTIPES, new species.

Male.—Length 5.5 mm.; of wing the same. Face wide, covered with brown pollen. Front green, the brown pollen of the face extends a little above the antennae and narrowly along the orbits. Antennae wholly black; third joint nearly one and a half times as long as wide, rounded at tip. Orbital cilia wholly black.

Thorax and abdomen dark green, rather shining; pleurae with gray pollen. The pollen of the abdomen more gray than white, rather abundant. Hypopygium black; its lamellae of moderate size, somewhat oval, but truncate at apex, dark brown without a distinct black border, jagged and bristly on apical margin, fringed above with long black hairs, below with a few short ones.

Coxae and femora black, knees scarcely paler. Fore and middle coxae with long black hairs on their anterior surface. Middle femora with two preapical bristles, placed very close together so as to appear almost like one; I can see but one preapical bristle on hind femora; middle and hind femora ciliated with black hairs below, those on the former shorter, those on the latter longer than the width of the femora. Fore and hind tibiae black, the latter thickened at basal third and at tip, becoming more slender between these points. Middle tibiae black with a white ring, which covers more than onethird their length and is not complete, the lower edge of the tibia being wholly black, the middle basitarsi are also white, with the base and tip narrowly black, the white ground color of the tibiae and tarsi is covered with silvery pollen. Fore tarsi about one and a fourth times as long as their tibiae, black, first joint with a slightly variable ring, which is not as dark as the rest of the joint. Middle tarsi about equal to their tibiae in length. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 23) grayish with a distinctly defined blackish tip, beginning at the tip of second vein; costa slightly enlarged at tip of first vein; last section of fourth vein a little bent at basal third; hind margin of wing indented at tip of fifth vein; anal angle not at all prominent.

Female.—Face as in the male, only slightly wider; third antennal joint shorter; legs and feet wholly black, without any trace of white on middle pair; middle and hind femora not ciliated; middle basitarsi without a bristle above, but with several small ones below; wings about as in the male, except that the cloud at tip is not as distinct, and the bend in the last section of fourth vein is a little nearer the middle.

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Described from 2 males and 1 female, taken on Mount Rainier, in Paradise Valley, Washington, at an elevation of 8,000 feet, Aug. 3-5, 1919, by C. L. Fox.

The hairs of the coxae and legs although black appear to be yellow or white when viewed in certain lights, the bristles of hind tibiae may appear whitish at tip or black at base and tip while the center is white.

Type and allotype in the California Academy of Sciences.

No. 24. DOLICHOPUS ACUMINATUS Loew.

Dolichopus acuminatus Loew, Neue Beitr., vol. 8, 1861, p. 12; Mon. of N. Amer. Dipt., pt. 2, 1864, p. 34.—Melander and Brues, Biol. Bull., vol. 1, 1900, p. 148.—Johnson, Insects of N. J., 1909, p. 756.

Male.—Length 3-4 mm.; of wing 3 mm. Face narrow, silvery. Front dark shining green. Antennae (fig. 242) wholly black; third joint only a little longer than wide, somewhat oval but with a little point at tip; lower orbital cilia white, the black cilia descend about one-third the eye height.

Thorax dark shining green; pleurae a little dulled with white pollen. Abdomen dark shining green with black incisures and a little white pollen on the lower edges of sides. Hypopygium black; its lamellae (fig. 24) large, nearly as long as the hypopygium, about three times as long as wide, acutely pointed at tip, white with a black border which is narrow on the upper and lower edges but becomes wider toward the tip, fringed with dark hairs on the edges.

Coxae, legs, and feet black, knees, extreme base of fore and middle tarsi and fore tibiae more or less, sometimes mostly yellowish. Fore coxae with very minute black hairs. Middle and hind femora each with one preapical bristle, the latter without cilia below. Posterior tibiae only slightly thickened; the glabrous stripe on the upper surface can be seen as a narrow shining line between the rows of bristles. Fore tarsi scarcely as long as their tibiae, the first joint about equal in length to the remaining four taken together. Middle and hind tarsi only a little longer than their tibiae. Calypters and halteres yellow, the former with black cilia.

Wings grayish; costa not thickened at tip of first vein; last section of fourth vein a little bent before its middle; hind margin not or scarcely indented at tip of fifth vein, evenly rounded, the anal angle not being much developed.

Female.—Face wider than in the male, silvery white; the third and fourth veins seem a little less convergent than in the male. Middle tibiae with one bristle below; their basitarsi without a bristle above.

Redescribed from many males and females taken at: Algonquin, Illinois, July 9; Battle Creek, Michigan (Aldrich); Socorro, New Mexico (Williston); Ithaca, New York, July; western New York, May-August.

Type locality.—District of Columbia and Illinois. Melander and Brues report it from Wisconsin. Insects of New Jersey from Westville, May 19, and Clementon, May 30.

No. 25. DOLICHOPUS BEATUS, new species.

Male.—Length 4.5 mm.; of wing the same. Face wide, silvery white. Front dark green, shining. Antennae black; third joint a little longer than wide, somewhat pointed at tip. Orbital cilia wholly black.

Thorax dark green, shining, but with traces of brown pollen on the front of the dorsum, which is visible only when viewed in certain directions; pleurae dulled with gray pollen. Abdomen dark green with coppery reflections on fourth and fifth segments and black incisures; there are only faint traces of white pollen on the lower part of the sides. Hypopygium (fig. 25) small, about the size of the fifth abdominal segment, black; its lamellae small, black, somewhat crescent shaped, their convex edge fringed with delicate hairs.

Coxae and femora black, their extreme tips yellow. Middle and hind femora each with two preapical bristles, placed one below the other, the lower one being a little nearer the base of the femora than the upper one. Fore tibiae and basal half of first tarsal joint yellow. Fore tarsi but little longer than their tibiae, infuscated from near the middle of the first joint (middle and hind tibiae missing). Calypters and halteres yellow, the former with black cilia.

Wings grayish, almost imperceptibly tinged with brown along the front; costs scarcely enlarged at tip of first vein; last section of fourth vein a little bent just beyond its basal third; hind margin of wing a little indented at tip of fifth vein; anal angle of wing rounded; tips of third and fourth veins not very close together.

Female.—Length 5 mm. Face gray, very wide; third antennal joint about as in the male only a little shorter; front dark green, sometimes with violet reflections at the vertex. Abdomen dark, almost blackish green; legs and feet black; anterior tibiae and basal half, sometimes the whole, of middle tibiae yellowish; front tarsi only a little paler at base; middle and hind femora each with two preapical bristles; wings as in the male. Middle tibiae with two bristles below; their basitarsi without a bristle above.

Described from 1 male and six females taken on Craig's Mountain, Idaho, by J. M. Aldrich.

Type.-Male, Cat. No. 22988, U.S.N.M.

No. 26. DOLICHOPUS DEMISSUS, new species.

Male.—Length 4 mm.; of wing 3.5 mm. Face rather narrow, its pollen yellow. Front green. Antennae (fig. 26a) wholly black; third joint but little longer than wide, rounded at tip. Orbital cilia wholly black.

Thorax green with coppery reflections; pleurae dulled with grayish pollen. Abdomen green with coppery reflections and black incisures, somewhat dulled with white pollen, which forms large spots on the sides of the segments. Hypopygium black; its lamellae large, rounded apically, sordid whitish with broad black apical border, a little jagged and bristly at apex, fringed with delicate hairs on upper edge.

Coxae black with grayish pollen; anterior pair with small black hairs on anterior surface, the usual row of bristles at tip rather small. Femora black, fore and middle pairs becoming yellowish on apical third, the yellow extending farther toward the base on the sides of the middle pair, which have a shining black spot at base on posterior surface. Middle and hind femora each with one preapical bristle, the latter without cilia below. Fore and middle tibiae yellow, sometimes a little darkened; hind tibiae and tarsi black, the former with a narrow glabrous stripe above, just inside of the inner row of large bristles, very slightly swollen at basal third on inner side and at tip; fore and middle tarsi a little longer than their tibiae, black from the tip of the first joint. Calypters and halteres yellow, the former with black cilia and the latter with their stems darkened.

Wings grayish (fig. 26), tinged with brown in front, which color fades out at the fourth vein; costa with a small knotlike enlargement at tip of first vein; last section of fourth vein slightly bent just before its middle; tip of third vein bent backward, but not very close to tip of fourth vein at the wing margin; hind margin of wing scarcely indented at tip of fifth vein; anal angle prominent.

Described from 1 male taken by me at Brawn's Mills Junction, New York, June 9, 1907.

Type.—Male, Cat. No. 22989, U.S.N.M.

No. 261. DOLICHOPUS BURNESI, new species.

Male.—Length 4 mm.; of wing 5.4 mm. Face narrow, silvery white, a little yellowish above. Front dark shining green. Antennae wholly black; third joint scarcely longer than wide, obtusely pointed at tip. Lateral and inferior orbital cilia whitish, about nine of the upper cilia on each side black. Proboscis and palpi black, the latter with a little white pollen.

Thorax and abdomen dark green or blue-green, very shining. Pleurae dulled with white pollen. The white pollen on the abdomen forms spots on the sides of the segments and extends upon the dorsum. Hypopygium black, its lamellae rather large, somewhat triangular, but a little rounded on apical margin; yellowish white, more yellow near the edges, with a broad black apical border, which shades into the yellow color extending along its inner edge; apical margin jagged, with one or two branched bristles at the lower corner, and long bristle-like hairs above them.

Coxae and femora black or metallic green, with their tips narrowly Fore coxae with white pollen and minute black hairs on the anterior surface; there are a few little white hairs on upper outer Middle and hind femora each with one preapical bristle. the latter with a row of little whitish hairs on lower inner edge, which are about the same length as the black hairs along the upper edge toward the base; they are so short that they could scarcely be called cilia. Fore and middle tibiae yellow, the latter with one bristle below, middle basitarsi without a bristle above. Posterior tibiae a very little thickened apically; black with a reddish shade on basal half of upper surface. Fore tarsi (fig. 261a) one and one-fourth times middle tarsi, about the length of their tibiae, black from the tip of the first joint, which is vellow. Fore tarsi with the first joint as long as the three following joints taken together, fifth shorter than fourth. Hind tarsi wholly black. Calypters and halteres yellow. the former with black cilia.

Wings grayish; costa scarcely enlarged at tip of first vein; last section of fourth vein bent beyond its basal third; third vein approaching fourth a very little at their tips; hind margin of wing scarcely indented at tip of fifth vein, evenly rounded, the anal angle being nearly obsolete.

Female.—Face wide, silvery white; fore tarsi as long, middle tarsi a little longer than their tibiae, black from the tip of the first joint, first joint yellow or brownish; hind tibiae yellow with their tips black for one-third their length and with the black extending up the inner surface as a line nearly to their base. Wing as in the male except that the third vein is a little straighter and approaches the fourth a little less at their tips, and the anal angle of wing is a little fuller.

Described from 2 males and 1 female taken by E. J. Burnes on Staten Island, New York; the female was taken Sept. 1.

This bright little species resembles setifer Loew, but has larger and darker lamellae, which are very much like those of albiciliatus Loew; it also differs from the former in not having a blackish spot at tip of wing; from the latter it differs in having the hind tibiae almost wholly black, and in the hind femora not having long black cilia, but only little short pale hairs on the lower inner edge.

Type.-Male, Cat. No. 22990, U.S.N.M.

No. 27. DOLICHOPUS CONSPECTUS, new species.

Male.—Length, 3.5-4 mm.; of wing, 3.5 mm. Face rather wide, slightly narrowed below, silvery white. Front green with coppery reflections, not very bright. Antennae black; first joint yellow below, still in some individuals almost wholly black; third joint not much longer than wide, somewhat orbicular in outline, but slightly

pointed at tip. Lateral and inferior orbital cilia white, about seven of the upper cilia on each side black.

Thorax green with bronze reflections, dorsum dulled with grayish pollen on its anterior portion; pleurae dulled with white pollen. Abdomen green with coppery reflections and with a little white pollen on the sides. Hypopygium black, rather short; its lamellae (fig. 27a) of moderate size, oval, white with a narrow black border at tip, only a little jagged on apical margin, fringed with brown hairs, which are stouter on the apical edge.

Coxae and femora black with yellow tips. Fore coxae with white pollen on their anterior surface, the inner half of which has minute black hairs and the outer side is nearly bare. Middle and hind femora each with one preapical bristle, the latter more or less yellowish at base and on inner side, ciliated with white hairs for nearly their whole length, the longest of these hairs nearly as long as width of femora. Fore and middle tibiae yellow. Hind tibiae black, more or less yellow at base; thickened and a little compressed; the glabrous stripe on upper edge not conspicuous, but extending two thirds their length. Fore tarsi about one and a fourth times as long as their tibiae, black from the tip of the first joint, which is about as long as the three succeeding joints taken together. Middle tarsi one and a third times as long as their tibiae black from the tip of the first joint, still sometimes infuscated almost to their base. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia, but there is a row of pale hairs back of the cilia and if the latter are broken off these pale hairs would be mistaken for the true cilia.

Wings grayish (fig. 27); costa scarcely enlarged at tip of first vein; last section of fourth vein a little bent before its middle; hind margin of wing scarcely indented at tip of fifth vein, evenly rounded, the anal angle being but little developed.

Female.—Face wide, silvery white; fore coxae with little black hairs on their entire anterior surface; hind femora more yellowish than in the male, without cilia below, but with a row of delicate, short, pale hairs on lower inner edge; hind tibiae of normal size, yellow with black tips. Otherwise about as in the male. Middle basitarsi without a bristle above.

Described from 3 males and 8 females, taken by J. M. Aldrich at Market Lake, Idaho, June 18; 1 male by W. M. Wheeler from Little Wind River, Wyoming, Sept. 2; and 1 pair by C. F. Baker from Colorado.

Type.—Male, Cat. No. 22991, U.S.N.M.

No. 28. DOLICHOPUS AGRONOMUS Melander and Bruce.

Dolichopus agronomus Melander and Brues, Biol. Bull., vol. 1, 1900, pp. 140 and 148.—Aldrich, Cat. N. Amer. Diptera, 1905, p. 299.

Male.—Length 3.5-4 mm.; of wing 3-3.75 mm. Face rather wide and perhaps rather long (Melander and Brues in their description say it is very long, I should not call it unusually so, but it appears longer on account of the lower portion below the usual transverse ridge being very short). Front silvery white, still the green ground color shows through in certain lights. Antennae wholly black (fig. 28a); third joint large, nearly twice as long as wide, pointed at tip; arista only a little longer than the antenna, inserted a short distance before the point. Cilia of the lateral and inferior orbits white, a few of the upper cilia black.

Thorax green with slight bronze reflections; dorsum covered with thin white pollen, which leaves a median shining vitta, this vitta in some specimens is slightly coppery with a fine green line on each side; pleurae more blackish with grayish pollen. Abdomen green with coppery reflections along the center of the dorsum and narrowly black at the incisures, covered with white pollen which is more conspicuous on the lower part of the sides. Hypopygium black; its lamellae rather small, oval, jagged at apex where there are the usual bristles.

Coxae black with yellow tips and white pollen, that on the anterior surface of fore pair silvery; the hairs on anterior coxae yellowish. Femora black, their tips and the trochanters yellow; middle and hind femora each with one preapical bristle, the latter with very delicate whitish cilia on lower inner edge, the longest of these hairs about half as long as width of femora (sometimes the cilia are shorter and so delicate as to be easily overlooked). Fore and middle tibiae yellow; posterior pair black, slightly thickened, the usual glabrous stripe on upper surface narrow but extending their whole length. Fore tarsi yellow, infuscated toward their tips (in the type specimen black from the tip of the first joint), a little longer than their tibiae, which are also short. Middle tarsi about one and a half times as long as their tibiae, yellow at base, becoming blackish at tip. Hind tarsi black. Calypters, their cilia and the halteres yellow (I do not see the strong black hair among these cilia mentioned by Melander and Brues in their description).

Wings a little grayish (fig. 28); costa not or scarcely enlarged at tip of first vein; last section of fourth vein bent before its middle, nearly parallel with third beyond this bend, still the third vein bent back a little at tip; hind margin of wing scarcely indented at tip of fifth vein; anal angle nearly obsolete, the wing being much narrowed at base; root of wing yellow, veins blackish.

Female.—Face nearly as wide as the front, silvery white; front with white pollen which nearly conceals the ground color; antennae with the third joint about as long as wide. Thorax and abdomen about as in the male; fore tarsi shorter than their tibiae, black from the tip of the first joint; middle tarsi scarcely longer than their tibiae, black from the tip of first joint, first joint without a bristle above; middle tibiae with one bristle below; hind tibiae and tarsi as in the male, except that the tibiae are more yellow at base. Cilia of calypters black. Wings as in the male, except that the anal angle is a little more prominent.

Redescribed from the type specimen in the American Museum, which was taken at New Bedford, Massachusetts, June 8; 1 male and 2 females taken in the same location as the type by Hough, May 13 and 31, 1896 (coll. of J. M. Aldrich); and 2 males taken by C. W. Johnson at Woods Hole, Massachusetts, June 19.

No. 29. DOLICHOPUS GRATUS Loew.

Dolichopus gratus Loew, Neue Beitr, vol. 8, 1861, p. 16; Mon. N. Amer. Diptera, pt. 2, 1864, p. 29.—Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 7.—Melander and Brues, Biol. Bull., vol. 1, 1900, p. 148.—Johnson, Insects of New Jersey, 1909, p. 756.

Male.—Length 4-4.5 mm.; of wing 4-5 mm. Face narrow, sordid white, darker on upper part, sometimes tinged with yellow. Front green, usually with blue reflections. Antenna (fig. 29a) wholly black; third joint about as long as wide, a little pointed at tip. Palpi black. Orbital cilia wholly black.

Thorax dark green, shining, with blue and sometimes bronze reflections; pleurae dulled with a little whitish pollen. Abdomen green with beautiful blue reflections and black incisures; the white pollen on its sides conspicuous. Hypopygium black; its lamellae rather large, whitish with black border, rather truncate at apex, deeply jagged and bristly on apical margin, fringed on the sides with black bairs.

Coxae black, their tips a little yellowish; fore coxae with white pollen and rather long black hair on their anterior surface and strong black bristles at tip. Middle and hind femora each with one preapical bristle, the latter ciliated with strong black hairs on lower inner edge, the longest of which are fully as long as the width of the femora. Middle femora with a fringe of delicate pale hairs on their lower edge, the longest of which are not half as long as the width of femora, these hairs appear blackish in certain lights and end near the tip with several little black bristles; the fore femora also have a fringe of delicate little pale hairs on lower edge, but they are not as long as those on the middle pair, these also end in several little black bristles. Fore and middle tibiae yellow, with strong bristles. Hind tibiae

black, except a yellow space on their upper surface extending from the knee for one-third, sometimes one-half, their length and shading into the black on the sides of the femora, sometimes the femora are yellow at base even on the lower side; there is also a short, yellow, depressed streak at the apical end of the glabrous stripe on upper edge; inside of the inner row of large bristles is another glabrous stripe; they are gradually but considerably thickened from base to tip. Fore tarsi a little longer than their tibiae; first joint nearly as long as the remaining four joints taken together; fourth joint about equal to the fifth in length, wholly or almost wholly yellow. Middle tarsi a little longer than their tibiae, yellow, becoming slightly infuscated toward their tips. Hind tarsi one and a third times as long as their tibiae, deep black. Calypters and halteres yellow, the former with black cilia.

Wings grayish (fig. 29); veins yellowish brown; costa black, thickened at tip of first vein, gradually tapering to its tip; last section of fourth vein moderately bent before its middle; tips of third and fourth veins rather close together; hind margin of wing scarcely indented at tip of fifth vein, evenly rounded, the wing being rather broad in the middle and the anal angle not prominent.

Female.—Face rather wide, silvery white; hind femora not ciliated but with a fringe of little hairs below; fore and middle femora fringed about as in the male, but the hairs scarcely as long; fore and middle tarsi more infuscated; the yellow of hind tibiae more extensive; costa not enlarged at tip of first vein.

Redescribed from many males and females from New York, Illinois, Michigan, and Canada. Melander and Brues report it from Wisconsin; Aldrich from the White Mountains, New Hampshire. Johnson in Insects of New Jersey from Palisades and Dunnfield, New Jersey.

Type locality.—New York.

Type.—In Museum of Comparative Zoology, Cambridge, Massachusetts.

No. 30. DOLICHOPUS CALCARATUS Aldrich.

Dolichopus calcaratus Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 8.—Melander and Brues, Biol. Bull., vol. 1, 1900, p. 148.

Male.—Length, 5-5.5 mm.; of wing, 4-5 mm. Face rather narrow, yellowish brown. Front shining green. Antennae wholly black; third joint somewhat conical in outline, not much longer than wide. Orbital cilia wholly black.

Thorax green, shining, sometimes with blue, in others with bronze vittae; pleurae more black with gray pollen. Abdomen dark green with black incisures. Hypopygium black; its lamellae (fig. 30a) large, oval, but rather truncate at apex, whitish, but sometimes the broad black border shades into the disk so they are mostly brownish,

deeply jagged and bristly on apical margin, fringed with long hairs on the edges.

Coxae black with yellow tips; anterior pair with coarse black hair on the front surface and strong bristles at tip. Femora black with yellow tips; middle and hind pairs about as in gratus Loew. Fore and middle tibiae yellow. Hind tibiae black, only a little yellowish at base, the yellow not extending over one-fourth their length on upper edge. All tarsi as in gratus. Calypters and halteres yellow, the former with black cilia.

Wings like those of gratus (fig. 30), except that the veins are blackish.

Female.—Like the female of gratus, except that the hind tibiae are only a little yellowish at base, the yellow not extending over one-third their length on upper edge.

Redescribed from the type specimen in the collection of J. M. Aldrich; it was taken at Dover, New Jersey, June 18; 1 male taken at Franconia, New Hampshire, by Mrs. Slosson; 1 pair taken at Colden, New York, July 30 and Aug. 23; 2 males from Boston, New York, July 10; 1 female taken at East Aurora, New York, July 29; 1 male taken at Bond Lake, Ontario, July 16; and 3 males and 5 females taken at Kearney, Ontario, July 3.

I have carefully compared the type and the other specimens with a long series of gratus and can find no noticeable difference, except the color of the hind tibiae, but there seems to be no grading in the coloring of the series of gratus and the series of calcaratus.

No. 31. DOLICHOPUS MELANDERI, new species.

Male.—Length, 4 mm.; of wing, 3.5 mm. Face rather wide, silvery white. Front shining green, sometimes bronze brown. Antennae black; first joint yellow below, usually conspicuously so; third joint about as long as wide, somewhat orbicular in outline, but pointed at tip. Lateral and inferior orbital cilia white, about seven of the upper cilia on each side black.

Thorax green with coppery reflections, sometimes mostly coppery, a little dulled with gray pollen, especially along the front edge; pleurae with white pollen. Abdomen green with coppery reflections on the hind margins of the segments, and a little white pollen on its sides. Hypopygium black; its lamellae moderately large (fig. 31a) somewhat quadrilateral in outline, but with the tip rounded, white with a narrow black border on upper and apical margins which are a little jagged and bristly.

Coxae and femora black, extreme tips of coxae, trochanters and extreme base and tips of femora yellow, the yellow sometimes more extensive on the hind femora. Anterior coxae with white pollen and little black hairs on their front surface. Middle and hind femora

each with one preapical bristle, the latter ciliated on lower inner edge with stiff white hairs on apical two-thirds, these hairs nearly as long as the width of the femora, they do not quite reach the tip. Fore and middle tibiae yellow; hind tibiae black, moderately thickened, yellow on their upper edge for one-third their length. Fore and middle tarsi a little longer than their tibiae, black from the tip of first joint, the joints of regularly decreasing length; fore basitarsi about as long as the three following joints taken together; middle basitarsi about as long as the two following joints and without a bristle above. Hind tarsi wholly black. Calypters and halteres yellow, the former with pale cilia, still there are usually a few black hairs among the cilia.

Wings grayish (fig. 31); costa scarcely enlarged at tip of first vein; last section of fourth vein bent beyond its basal third; third and fourth veins nearly parallel beyond the bend; hind margin of wing scarcely indented at tip of fifth vein, nearly evenly rounded, anal angle of wing not very prominent.

Described from 7 males taken by A. L. Melander in Washington, 1 at Prosser, May 4, 1911, and 6 at Kennewick, June 7, 1916.

Type taken at Kennewick, Washington, and in the A. L. Melander collection. One paratype in the United States National Museum.

Paratype.—Male, No. 22992, U.S.N.M.

No. 32. DOLICHOPUS JOHNSONI Aldrich.

Dolichopus johnsoni Aldrich, Kansas Univer. Quart., vol. 2, 1893, p. 7.

Male.—Length 3.2-4 mm.; of wing 3-3.2 mm. Face narrow, yellowish on upper portion, more white below, sometimes entirely white. Front green, not very dark, shining. Antennae (fig. 32a) wholly black; third joint a little longer than wide, its form nearly a perfect oval. Palpi yellowish brown. Orbital cilia wholly black.

Thorax green, dorsum with more or less bronze reflections and a little white pollen on the front edge; pleurae more blackish with white pollen. Abdomen green with black incisures and slight bronze reflections; the white pollen on its sides abundant and visible almost to the center of the dorsum. Hypopygium black; its lamellae rather small, somewhat triangular in outline, but rounded on upper corner, white with a narrow black border apically, where it is jagged and bristly.

Coxae black with narrow yellow tips. Fore coxae with white pollen and little black hairs on their anterior surface. Femora black with yellow tips. Middle and hind femora each with one preapical bristle, the latter with brown cilia on lower inner edge of apical half, the longest of these hairs about three-fourths as long as width of femora. Fore and middle tibiae yellow. Hind tibiae black, a little thickened, the glabrous stripe on upper surface can

scarcely be traced. Fore tarsi about one and a fourth times as long as their tibiae, yellow, the tips of the joints being brown, sometimes they are infuscated from the tip of the first joint, basitarsi about the length of the three following joints taken together, fourth and fifth joints of about equal length. Middle tarsi a little longer than their tibiae, black from the tip of the first joint. Hind tarsi one and a half times as long as their tibiae, wholly black. Calypters and halteres yellow, the former with black cilia.

Wings strongly and rather uniformly tinged with blackish (fig. 32), but often more gray toward their base and along the hind margin; costa with a small knotlike enlargement at tip of first vein; last section of fourth vein slightly bent before its middle; hind margin of wing slightly indented at tip of fifth vein; anal angle prominent, the wing being of nearly equal width.

Female.—Face narrow for a female, yellowish gray; third antennal joint very small; hind femora not ciliated; wings strongly tinged with yellowish brown in front as far back as the fourth vein and narrowly brownish along the fifth and cross veins; back of fourth vein the wing is brownish gray; wings shaped about as in the male, still a little more rounded on hind margin.

Redescribed from the type specimen in the collection of J. M. Aldrich taken at Jamesburg, New Jersey, July 4, 1891; also 1 female taken at the same place on July 4, 1894; 2 males taken by N. Banks at Beltsville, Maryland, June 9, in a swamp; and 1 male taken by W. L. McAtee, at Beltsville, Maryland, July 4, 1916.

No. 33. DOLICHOPUS APPENDICULATUS, new species.

Male.—Length 4 mm.; of wing 3.8 mm. Face long, reaching below the lower corner of the eye, rounded below, without the transverse ridge which usually separates the upper from the lower portion of the face in this genus, silvery white. Front green, usually with bronze reflections and somewhat dulled with whitish pollen. First two joints of antennae mostly yellow, black or brown on upper edge; third joint about one and a half times as long as wide, oval, but obtusely pointed at tip; arista inserted a little before the tip of third joint, longer than the antenna. Lateral and inferior orbital cilia silvery wnite, much flattened, the black cilia of upper orbit short and stout, reaching down about one-third of the eye height.

Thorax shining green, sometimes with bronze reflections, which form in some specimens as many as five indistinct vittae on the dorsum; in one female the dorsum is more coppery than green; pleurae scarcely dulled with pollen. Abdomen shining green, usually with coppery reflections on the dorsum before the incisures, the last two segments mostly coppery on the upper surface. Hypopygium black; its lamellae rather large, somewhat triangular in out-

line, whitish but tinged with brown, apical and upper edges rather broadly bordered with black, jagged and bristly at apex, fringed with delicate black hairs on upper edge.

Coxae black, the anterior pair tinged with green and with thick silvery pollen and very minute white hairs on the front surface; the usual row of bristles at tip are strong. Femora black with green reflections, their tips yellowish, the middle pair has the yellow more extensive and paler. Middle and hind femora each with one preapical bristle, the latter not ciliated but with a row of minute brown hairs on lower outer edge, upper edge fringed with rather long black hairs; these are longest near the base. Fore tibiae blackish, sometimes a little vellowish on apical half. Middle tibae brownish vellow, sometimes quite dark, darker at base on posterior surface, with three large bristles on lower side and three on posterior side; on the upper surface near the middle is a bristle-like appendage (fig. 33a), which is a little shorter than the middle basitarsi and is a little enlarged at tip. Hind tibiae a little thickened, shining black, with three or four large bristles below. Fore tarsi a little longer than their tibiae, black, their joints of decreasing length. Middle tarsi (fig. 33b) slender, about once and a half as long as the tibiae; fifth joint about as long as fourth, a little compressed, widened toward the tip; first four joints pale yellow, their tips enlarged and black, each joint narrowed at Hind tarsi wholly black, their basitarsi with two large bristles above. Calypters, their cilia, and the halteres yellow.

Wings grayish (fig. 33), usually tinged with brown along the front for a short distance, from the tip of the second vein toward the base; costa enlarged so as to fill all the space between the costa and the first vein, except a small open spot near the root of the wing, seen from the front edge of the wing this enlargement appears flattened with its tip obliquely truncate, ending in a little point on lower angle, this enlargement velvety black; last section of fourth vein considerably bent at its middle; tip of third vein bent backward; hind margin of wing scarcely indented at tip of fifth vein; anal angle of wing very prominent, the wing being of nearly parallel width, but a little wider just before the anal angle than in the middle.

Female.—Differs from the male in having the face wider and more grayish white than silvery; third antennal joint shorter; fore coxae with black hairs; fore and middle tibiae black; middle tarsi plack with the extreme bases of the joints yellowish, tips of first four joints a little enlarged, fifth joint a very little compressed, but not as much as in the male; wings as in the male, except that the costa is not at all enlarged at tip of first vein, the cell between the costa and the first vein is more or less tinged with brown, and the anal angle of wing is not quite as prominent.

Described from 7 males and 4 females. Prof. J. M. Aldrich took 2 males and 2 females at Wells, Nevada, July 12, 1911; I took 4 males and 2 females at the same place June 6, 1915, and 1 male at Saltair, on Great Salt Lake, Utah, June 8, 1915.

Type.—Male, Cat. No. 22993, U.S.N.M., from Wells, Nevada.

No. 34. DOLICHOPUS FUMOSUS, new species.

Male.—Length 3.5 mm.; of wing 3 mm. Face rather wide, yellowish. Front green. Antennae (fig. 34a) black, first joint slightly yellowish below; first and second joint short; third joint about three times as long as wide with an acute point at tip, its pubescence conspicuous; arista but little longer than the third joint and inserted just above its tip, inferior orbital cilia whitish, about six of the upper cilia on each side black.

Thorax greenish brown, dulled with brownish gray pollen, which leaves when viewed in certain directions three shining vittae; pleurae with grayish pollen. Abdomen bronze brown with green reflections and with large spots of white pollen on the sides of the segments. Hypopygium black; its lamellae small, oval, narrowed into the stem, whitish with a black border, jagged and bristly at apex and with delicate hairs on upper edge.

Coxae black, their extreme tips and the trochanters yellow. Fore and middle femora black with broad yellow tips. Middle and hind femora with one preapical bristle, the latter black and apparently without cilia below. Fore and middle tibiae yellow; hind tibiae brownish yellow, becoming black at tip, but little thicker than the others, the glabrous stripe on upper surface extending nearly their entire length; fore and middle tarsi about equal to their tibiae in length, yellow, infuscated from the tip of first joint, still each joint paler at base. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 34) grayish; costa enlarged at tip of first vein, gradually tapering to its tip; last section of fourth vein a little bent at its basal third; third and fourth veins nearly parallel beyond this bend; hind margin of wing scarcely indented at tip of fifth vein, evenly rounded; anal angle broadly rounded.

Described from 1 male taken at Farwell Creek, South Saskatchewan, Canada, in July, 1907, by Dr. E. M. Walker.

Type.—Male, Cat. No. 22994, U.S.N.M.

This species has remarkable antennae; the acute point, conspicuous pubescence, and nearly apical arista, are rarely found in this genus.

No. 35. DOLICHOPUS CONVERGENS Aldrich.

Dolichopus convergens Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 9.

Male.—Length 4 mm.; of wing 3.8-4 mm. Face rather narrow, silvery white. Front green or blue green. Antennae (fig. 35a) wholly black; third joint oval, not much longer than wide, obtusely pointed at tip. Lateral and inferior orbital cilia yellowish white, the black cilia descending about one fourth the eye height.

Thorax dark green, dorsum dulled with nearly invisible brown pollen and with blue reflections; pleurae dulled with a little grayish pollen. Abdomen dark green with narrow black incisures, slight blue reflections and a little white pollen on the lower part of the sides. Hypopygium black; its lamellae are not very large, somewhat triangular in outline, whitish with a moderately wide border, jagged and bristly at apex and with a few delicate hairs on the upper and lower edges.

Coxae black with yellow tips; anterior pair with silvery pollen and little black hairs on the front surface, the usual row of bristles at tip. Trochanters yellow. Femora black with yellow tips. Middle and hind femora each with one preapical bristle, the latter without cilia below. Tibiae yellow, posterior pair with their tips narrowly black, scarcely thickened. Fore and middle tarsi a little longer than their tibiae, black from the tip of the first joint, still the base of the second joint is yellowish. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 35) a little grayish; costa scarcely enlarged at tip of first vein; last section of fourth vein bent near its middle; third and fourth veins convergent, their tips about one-third as far apart as the tips of the second and third veins; fourth vein ending nearly the length of the cross-vein before the apex of the wing; hind margin of wing not indented at tip of fifth vein; anal angle obsolete, the wing being narrowed toward the base.

Female.—Face nearly as wide as the front, white; third antennal joint a little smaller; otherwise about as in the male.

Redescribed from one of the type specimens and several specimens from Mount Constitution, Washington, July 7 and 17; and Keyport, Washington, August 7 (Aldrich).

Type locality.—Mount Hood, Oregon.

No. 36. DOLICHOPUS NUBIFER, new species.

Male.—Length 4-4.5 mm.; of wing 4 mm. Face rather narrow, its sides nearly parallel, silvery white. Front shining green. Antennae wholly black; third joint about as long as wide, somewhat rounded at tip; arista longer than antenna. Orbital cilia wholly black.

Thorax dark green with coppery reflections, shining; pleurae dulled with gray pollen. Abdomen dark bronze green with black incisures and white pollen on the sides of the segments. Hypopygium black; its lamellae rather large, somewhat round in outline but narrowing suddenly into the stem, white with a broad black border on apical margin, which is a little jagged and fringed with long delicate hairs.

Coxae and femora black; trochanters and tips of femora yellow, the yellow more extensive on middle pair. Middle and hind femora each with two preapical bristles, placed one before the other, the latter without cilia below. Tibiae yellow; posterior pair black at tip for one-fourth their length; a little thickened, especially at tip, with a rather broad glabrous stripe on upper surface for nearly their whole length; this stripe seems to have an almost golden reflection, in certain lights, on the yellow portion (probably from a golden yellow pollen); the middle tibiae also show a trace of this color. Fore tarsi a very little longer, middle tarsi about the same length as their tibiae, both black from the tip of the first joint. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 36) tinged with dark gray and with an ill-defined cloud along the costa, from a little beyond the tip of first vein to the tip of third and extending back to or beyond the third vein, cross-vein also a little clouded; costa scarcely enlarged at tip of first vein; last section of fourth vein a little bent before its middle; tips of third and fourth veins rather widely separated; hind margin only a little indented at tip of fifth vein; anal angle of wing rounded, not prominent.

Female.—Agrees with the male, except that the face is wide; third antennal joint smaller, and the clouds on the wings very indistinct. The middle tibiae with one bristle below, their basitarsi without a bristle above.

Described from 3 males and 1 female which I took at Wells, Nevada, June 6, 1915.

Type.—Male, Cat. No. 22995, U.S.N.M.

No. 37. DOLICHOPUS BARBICAUDA, new species.

Male.—Length 4.3 mm.; of wing 3 mm. Face rather narrow, white, scarcely silvery, and with a slight yellowish tint. Front green with bronze reflections, more blue in one specimen. Antennae (fig. 37a) wholly black; third joint only a little longer than wide, ovate, but with a rather sharp point at tip. Lower orbital cilia yellowish white, the black cilia reaching down the middle of the eye.

Thorax green with bronze reflections, which sometimes form one to three vittae on anterior part of the dorsum; in one specimen the reflections are blue and the scutellum is almost violet; pleurae more

blackish, dulled with gray pollen. Abdomen green with black incisures and coppery reflections on the posterior margins of the segments. Hypopygium black; its lamellae (fig. 37) moderately large, somewhat triangular in outline, yellowish with long, black, bushy, very dense hair on apical portion and short black hairs on the whole outer surface, not at all jagged on apical margin.

Coxae and femora black, their tips and the trochanters yellowish. Fore coxae with black hairs on anterior surface, the usual bristles at tip. Middle and hind femora each with one preapical bristle, the latter not ciliate but fringed on lower outer edge with delicate little black hairs. Tibiae yellow: posterior pair rather stout, black at tip for one-fifth their length, the glabrous stripe on upper surface distinct and reaching the entire length. Fore tarsi about as long as their tibiae, brownish yellow, first joint a little shorter than the remaining four taken together, second joint very little longer than third, last three joints of nearly equal length, still the fourth a little the shortest. Middle tarsi slightly longer than their tibiae, infuscated from the tip of the first joint, but scarcely black. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia.

Wings grayish; costa not at all enlarged at tip of first vein; last section of fourth vein bent at its middle; hind margin of wing scarcely indented at tip of fifth vein; anal angle rounded, not prominent.

Female.—Agrees with the description of the male given above, except that the face is as wide as the front and is more grayish white; the hind tibiae have more black at their tips but it is less sharply defined and the wings are a little tinged with yellowish brown in front of the third vein. The delicate hairs on lower outer edge of hind femora are smaller than in the male. Middle tibiae with one bristle below, their basitarsi without a bristle above.

Described from 9 males and 4 females. Two males are in the collection of J. M. Aldrich; 1 male was taken at Montreal Island, Quebec, and 1 at Toronto, Ontario, May 23, 1896. One female was taken at Ottawa, Canada, July 2, 1912, by G. Beaulieu; 1 female at Summerside, Prince Edward Island, July 21, 1914, by Dr. E. M. Walker. I took the other specimens at Toronto, Ontario, July 4, 1911, and July 21, 1918.

Type.—Male, Cat. No. 22996, U.S.N.M., from Toronto, July 21, 1918.

No. 38. DOLICHOPUS BISETOSUS, new species.

Male.—Length 4-5 mm.; of wing 4-4.25 mm. Face rather wide, white, a little tinged with gray or yellowish gray. Front shining green with more or less distinct violet reflections. Proboscis, palpi, and their hairs black. Orbital cilia wholly black. Antennae (fig.

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38a) wholly black; third joint one and a hard as as long as wide, somewhat pointed at tip.

Thorax green, shining, sometimes with blood poppery reflections, which form narrow stripes on the dorsum; popper dulled with gray pollen. Abdomen green with blue and copper dections and black incisures; second segment with a patch of rather and vellowish white hair on each side near the lower edge, usually this is an englished conspicuous. Hypopygium black; its lamellae (fig. 38) and mall, somewhat circular in outline but nearly straight above, it is not jagged, fringed with delicate black hairs.

Coxae black with yellow tips; anterior pair with white policy black hairs on the front surface, fore and middle femora blac. yellow tips; middle pair black with apical third or more yellow black shading into the yellow. Hind femora nearly bare below with rather long hair on upper edge and two preapical bristles, one near! below the other; middle femora with two, often with three preapical Tibiae vellow: posterior tibiae black at tip, the black shading into the vellow and extending to or beyond the middle on inner side, a little stouter than the others, slightly swollen at basal third and at tip; the glabrous stripe on upper surface wide, extending upon the inner side of the inner row of large bristles for about onethird their length. Fore tarsi nearly equal to their tibiae in length; first joint scarcely as long as the remaining four taken together, brown from the tip of the first joint. Middle tarsi one and a fourth times as long as their tibiae, black from the tip of the first joint. Hind tarsi deep black, one and a third times as long as their tibiae. Calypters and halteres yellow, the former with black cilia.

Wings grayish, a little darker along the front; costa scarcely enlarged at tip of first vein; last section of fourth vein a little bent near its basal third; hind margin of wing scarcely indented at tip of fifth vein, not much rounded, the wing being of nearly equal width; anal angle rounded, not very prominent.

Female.—A number of females were taken with these which differ from the males in having all the femora black with the tips yellow; middle tibiae yellowish at base becoming black at tip, sometimes largely black; the tarsi all black, except the fore basitarsi, which are mostly yellow. The wings are more broadly rounded on the hind margin than in the male. The middle and hind femora each with two preapical bristles which are placed one nearly below the other; middle tibiae with two bristles below, their basitarsi with a large bristle above.

Described from 8 males and 12 females which were taken on Craig's Mountain, Idaho, and 1 male taken at Lawyer's Canyon, Idaho, June 16, 1909 (all by J. M. Aldrich).

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Type.—Male, Cat. No. 22997, U.S.N.M., from Craig's Mountain. The females described above seem to differ from the females which I have placed with D. beatus by their having a bristle on the upper surface of the middle basitarsus, which I can not find in the females placed as those of beatus.

No. 39. DOLICHOPUS INTENTUS Melander and Brues.

Dolichopus intentus MELANDER and BRUES, Biol. Bull., vol. 1, 1900, p. 137, figs.

Male.—Length 4 mm.; of wing 3.5 mm. Face moderately narrow, white. Front violet, narrowly green around the edges, shining. Antennae wholly black; third joint three times as long as wide, tapering to a point, the arista inserted just above this point, not much over one-half as long as the third joint. Orbital cilia wholly black.

Thorax dark green, not very shining; pleurae black with gray pollen. Abdomen dark greenish, almost bronze brown, shining, with but little white pollen on its sides. Hypopygium black; its lamellae (fig. 39) small, blackish, a little paler in the middle, nearly triangular in outline, not jagged or bristly, fringed on apical margin with delicate little brown hairs.

Coxae blackish; the anterior pair appear to be nearly bare; femora black with yellow tips. Middle femora with one preapical bristle (there may have been two and one have been broken off); hind femora with two preapical bristles, placed one above the other, without cilia below. Tibiae yellow; posterior pair black at tip, the glabrous stripe between the two rows of large bristles on upper surface narrow but distinct. Fore tarsi black from the tip of the first joint, not longer than the short fore tibiae; last four joints short, the fourth being slightly shorter than the fifth. Middle tarsi about one and a fourth times as long as their tibiae, black from the tip of the first joint. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia.

Wings grayish; veins black; costa with a small knotlike enlargement at tip of first vein; last segment of fourth vein a little bent near its basal third; third vein bent backward a little at tip; hind margin of wing scarcely indented at tip of fifth vein; anal angle rather prominent.

Redescribed from the single type specimen in the American Museum collection; it was taken at Chicago, Illinois, May 8, 1896.

No. 40. DOLICHOPUS ANGUSTICORNIS, new species.

Male.—Length 4 mm.; of wing the same. Face rather wide, silvery white. Front green, rather thickly covered with gray pollen. Antennae (fig. 40) wholly black, third joint large, nearly four times

as long as wide, pointed at tip; arista thore about two-fifths as long as third antennal joint and inserted just above its tip. Inferior

orbital cilia whitish, the upper cilia black.

Thorax green, dorsum dulled with whitish value, which leaves obscure vittae that are shining, the median one is conserved toppery; pleurae more black, dulled with gray pollen. Abdorner, seen with black incisures, covered with white pollen, which is third, on the sides and in certain lights leaves a central black vitta. It was simplified in outline, whitish with a narrow black border on apical and open margins, jagged and bristly on lower corner, fringed with long delicate hairs on apical and upper edges.

Coxae and femora black, tips of fore and middle coxae, trochenters and tips of femora yellow. Middle and hind femora each with one preapical bristle, the latter not ciliated, still they have a row blong pale hairs on lower inner edge, which are very delicate and not easily seen, they are about one-fourth to one-third as long as the width of the femora. Tibiae yellow; posterior pair black at tip for one-sixth their length and with a blackish spot on inner surface at basal third, only a little thickened, the glabrous stripe on upper surface is broad and extends nearly their entire length. Fore and middle tarsi a little longer than their tibiae, black from the tip of the first joint. Hind tarsi wholly black. Calypters, their cilia, and the halteres yellow.

Wings a little grayish; costa with a small knot-like enlargement at tip of first vein; last section of fourth vein a little bent just before its middle, from which point it is pearly parallel with third vein; hind margin of wing not indented at tip of fifth vein; anal angle prominent.

Female.—Face wider than in the male; third antennal joint large, long for a female, somewhat triangular in outline, acutely pointed at tip, arista nearly apical; thorax dulled with whitish pollen as in the male; wings without an enlargement at tip of first vein, otherwise as in the male. Middle tibiae with one bristle below, their basitarsi without a bristle above.

Described from 1 male and 1 female which were swept from winter wheat at Evansville, Indiana, May 7, 1914, by J. M. Aldrich.

Type.—Male, Cat. No. 22998, U.S.N M.

This species somewhat resembles intentus Melander and Brues, but it differs in having only one preapical bristle on the middle and hind femora, in having the front greenish, dulled with gray pollen, not metallic violet as in intentus; it also differs in the form of the lamellae.

No. 41. DOLICHOPUS AEQUALIS, new species.

Male.—Length 4 mm.; of wing the same. Face narrow, silvery white. Front shining green with a little brown pollen visible on lower part when viewed in certain directions. Antennae (fig. 41b) wholly black; third joint a little longer than wide, somewhat conical in outline. Orbital cilia wholly black, except that there are from two to five yellowish bristles on each side near the proboscis.

Thorax shining green, sometimes with an indistinct median copperty vitta; pleurae slightly dulled with grayish pollen. Abdomen dark green, its incisures black, the white pollen on the sides confined to the extreme lower edge of the dorsum. Hypopygium black with green reflections; its lamellae (fig. 41a) large, whitish with a narrow black border, but the apical half appearing blackish on inner side on account of the little black hairs on its surface, outer portion somewhat oval and at nearly right angles to the stem, jagged on outer edge and fringed with rather long hairs.

Coxae and femora black, the latter with yellow tips. Middle and hind femora each with one preapical bristle, the latter with a fringe of short brown hairs below; these hairs are delicate and scarcely as long as the row of black hairs on upper edge of basal half. Tibiae yellow; posterior pair with black tips. Fore tarsi (fig. 41b) about one and a fourth times as long as their tibiae, brownish, becoming black at tip, still a little yellowish at base; first joint about as long as the three succeeding joints taken together, second and third joints of nearly equal length, fourth and fifth joints also of nearly equal length but shorter than the preceding ones; last three joints slightly compressed and gradually widened; pulvilli white, conspicuous. Middle tarsi about one and a fourth times as long as their tibiae, black with the base of the first joint yellowish. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 41) grayish; costa not enlarged at tip of first vein; last section of fourth vein a little bent at about its basal third; hind margin of wing scarcely indented at tip of fifth vein; anal angle rounded, not very prominent.

Female.—Face broad, silvery white; hind femora with a row of rather long hairs on lower inner edge, but these are not as long as in the male. It agrees with the male in having one large bristle below on middle tibiae, the basitarsi being without a bristle above, in having the yellow bristles near the proboscis and in the wing form. The fore tarsi are scarcely longer than their tibiae and not noticeably compressed.

Described from specimens taken by me in Erie County, New York: 4 males and 1 female were taken at Colden, July 4, and August

19; 2 males were taken at Boston, New York, 10; and 2 males and 1 female were taken at East Aurora, A year 1.

This seems to be the same species as stood he made to we collection at Cambridge, under the MS. name of stenop. I could not find this specimen when looking over the collection 1919, but Professor Aldrich saw it when looking over the La 1901.

Type.—Male, Cat. No. 22999, U.S.N.M.

No. 42. DOLICHOPUS LITORALIS, new species.

Male.—Length 4 mm.; of wing 3.5 mm. Face moder. A salittle narrow below, silvery white. Front dark green. A swholly black; third joint but little longer than wide, oval in the line. Lateral and inferior orbital cilia whitish, a few of the silve cilia black.

Thorax dark green with coppery reflections, especially at t. suture; pleurae dulled with gray pollen. Abdomen green with slight coppery reflections. Hypopygium black; its lamellae (fig. 42) moderately large, somewhat quadrilateral in outline, whitish with a narrow black border on apical and upper margins, jagged and bristly on apical margin, fringed on upper edge with brown hairs.

Coxae and femora black, extreme tips of coxae, trochanters and extreme base and tips of femora yellowish. Fore coxae with minute black hairs on the anterior surface. Fore and middle femora each with one preapical bristle, the latter ciliated below with long white hairs on lower apical fourth, these hairs nearly as long as the width of the femora; the fore and middle femora also have a row of short but conspicuous white hairs on lower posterior edge. Tibiae yellow; posterior pair a little stouter than the others, their tips black for fully one-fourth their length; middle and hind tibiae each with one bristle below near apical fourth. Fore tarsi about one and a fourth times as long as their tibiae, first joint scarcely as long as the three succeeding joints taken together, third, fourth and fifth joints of nearly equal length, second only a little longer than third, each joint, beginning with the second, narrowed a little at base, so as to give the tarsi a serrate appearance. Middle tarsi one and a third times as long as their tibiae, black from the tip of the first joint, their basitarsi without a bristle above. Hind tarsi wholly black. Calvoters, their cilia and the halteres yellow.

Wings (fig. 42a) grayish, a very little tinged with brown in front of third vein; costa scarcely enlarged at tip of first vein; last section of fourth vein a little bent before its middle; third vein bent backward a little so as to approach the fourth at tip; hind margin of wing scarcely indented at tip of fifth vein; anal angle rather prominent, still the wing of somewhat equal width, a little narrowed at base.

Described from 2 males taken by A. L. Melander in Washington; 1 at Seattle, August 2, 1908, the other at Tacoma, August 27, 1911.

Type.—In the collection of A. L. Melander, and taken at Tacoma, Washington.

No. 42. DOLICHOPUS PACKARDI, new species.

Male.—Length 4 mm.; of wing the same. Face quite wide, a little narrowed below, silvery white. Front blue green, dulled with gray pollen. Antennae wholly black; third joint only a little longer than wide, conical in outline with the apex a little rounded. Orbital cilia black, but back of these, near the proboscis are several small and one or two large yellowish bristles. Proboscis and palpi black.

Thorax bronze brown with green reflections, dorsum dulled with grayish pollen, which forms indistinct vittae, this pollen is more white along the anterior and lateral margins of the dorsum; pleurae dulled with gray pollen. Abdomen green with coppery reflections; hind margins of the segments black; the white pollen on the sides abundant and extending over the dorsum. Hypopygium black; its lamellae moderately large, somewhat elliptical in outline with a slight sinus below, white with a broad black border on apical margin, which extends narrowly along the upper and lower edges, jagged and bristly at apex, fringed above with blackish hairs.

Coxae and femora black, with their extreme tips a little vellowish. Fore coxae thickly covered with white pollen and little black hairs on their anterior surface. Middle and hind femora each with one preapical bristle, the latter ciliate on lower inner edge with a few long pale hairs which appear more black at their base; the longest of these hairs are near the middle of the femora and are as long as the width of the femora; these cilia are continued nearly to the base of the femora by short brownish hairs. Tibiae yellow; middle pair a little infuscated at tip and with five bristles on lower surface; posterior pair a little thickened, black at tip, the black shading into the yellow; the glabrous stripe on upper side can be seen as a shining line between the rows of large bristles; there is also a glabrous space on inner surface, wide at base of tibiae and tapering to a shining line just inside of the inner row of bristles and extending to the tip. Fore tarsi nearly one and a half times as long as their tibiae, black almost to their base, which is a little yellowish brown, the joints of regularly decreasing length. Middle tarsi blackish, one and a half times as long as their tibiae, their basitarsi with a bristle above and several small ones below. Hind tarsi black, nearly twice as long as their tibiae, their basitarsus two-thirds as long as the tibia. Calvpters and halteres yellow, the former with black cilia.

Wings (fig. 43) dark grayish, slightly tinged with brown in front and along the veins; costa a very little thickened at tip of first vein,

tapering to its tip; last section of fourth vein: bent just beyond its basal third; third and fourth veins approximate other a little from the bend, still their tips rather far apart. In a regin of wing scarcely indented at tip of fifth vein; evenly round it anal angle not being prominent.

Described from 1 male taken by Prof. A. S. Packa district wherry Harbor, Labrader.

Type.—In the Museum of Comparative Zoology i. 'ge, Massachusetts.

No. 44. DOLICHOPUS XANTHOCNEMUS Loew.

Dolichopus zanthocnemus Loew, Mon. N. Amer. Dipt., pt. 2, 1864, : Coquillett, Proc. Wash. Acad. Sci., vol. 2, 1900, p. 424.

Male.—Length 4 mm.; of wing 3.75 mm. Face of moderate was silvery white. Front bluish green or bronze green. Antenn. (fig. 44a) wholly black; third joint nearly round in outline, a little pointed at tip; lateral and inferior orbital cilia whitish, a few of the upper cilia black.

Thorax green, not very shining, with slight bronze reflections, which sometimes take the form of vittae; pleurae a little dulled with gray pollen. Abdomen green with black incisures, covered with white pollen which is thickest on its sides and leaves a blackish stripe on the center of the dorsum in certain lights. Hypopygium black; its lamellae rather small, somewhat oval in outline, whitish with a black border at apex; jagged and bristly on apical margin.

Coxae black with their extreme tips and the trochanters yellowish. Femora black with yellow tips; the yellow on middle pair often shades into the black, making them more than half yellowish; hind pair sometimes yellowish below. Middle and hind femora each with one preapical bristle, the latter ciliate below with very delicate pale hairs, which are rather scattering and about as long as the width of the femora; the fore and middle femora have minute pale hairs below, which may be easily overlooked. Tibiae yellow; posterior pair black at tip for nearly one-third their length, the black part a little more thickened than the rest. Fore and middle tarsi a little longer than their tibiae, blackened from the tip of the first joint; fore tarsi with the third and fifth joints of equal length, the fourth being a little shorter. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 44) grayish; costa with a very small knot-like enlargement at tip of first vein; last section of fourth vein moderately bent before its middle; hind margin of wing not indented at tip of fifth vein; anal angle quite prominent, making the wing of somewhat equal width from tip of second vein to the anal angle.

Female.—Like the male, except that the face is a little wider and more white than silvery; the hind femora are without cilia, and the costa is not enlarged at tip of first vein.

Redescribed from 4 males and 3 females in the collection of J. M. Aldrich, 4 of these are from Colorado and were taken by C. F. Baker, and 3 from Mount Washington, New Hampshire, taken by Mrs. Slosson.

Type locality.—Sitka, Alaska. Coquillett reports from several places in Alaska.

No. 45. DOLICHOPUS ALBICILIATUS Loow.

Dolichopus albiciliatus Loew, Cent., vol. 2, 1862, No. 59; Mon. N. Am. Diptera, pt. 2, 1864, p. 31.—Wheeler, Psyche, vol. 5, 1890, p. 338.—Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 9; Cat. N. Amer. Diptera, 1905, p. 299.—Melander and Brues, Biological Bulletin, vol. 1, 1900, p. 148.

Male.—Length 4.5-5 mm.; of wing 4-4.5 mm. Face narrow, silvery white, a little yellowish just below the antennae. Front blue green. Antennae wholly black; third joint scarcely longer than wide, somewhat conical in outline, a little pointed at tip. Lateral and inferior orbital cilia white, a few nearest the black cilia yellowish; the black cilia descend nearly to the middle of the eye height.

Thorax shining blue green; pleurae dulled with gray pollen. Abdomen green with black incisures and sometimes with distinct coppery reflections; the white pollen on its sides is not very abundant. Hypopygium black; its lamellae (fig. 45a) rather large, nearly orbicular in outline but narrowed into the stem, whitish with broad black border on apical portion, which shades into the white, a little jagged on apical margin with one or two branched bristles at lower corner, otherwise fringed on apical edge with long, bent black hairs and on lower edge with short delicate brown hairs.

Coxae and femora black with yellow tips. Fore coxae with white pollen and little black hairs on the anterior surface. Middle and hind femora each with one preapical bristle, the former with short delicate hairs below and the latter ciliate with long black hairs on their lower surface, the longest of these hairs longer than the width of the femora. Tibiae yellow; posterior pair a little thickened, black on inner side and at tip on outer side for one-fourth their length. Fore tarsi a little longer than their tibiae; black from tip of first joint; first joint as long as the remaining four taken together. Middle tarsi longer than their tibiae, black from the tip of the first joint. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 45) grayish; costa with a small knotlike enlargement at tip of first vein; last section of fourth vein a little bent at its

middle; hind margin of wing scarcely indented at tip of fifth vein; anal angle not prominent.

Female.—Face wide, silvery white; hind tibiae yellow with black tips, the black being poorly defined, but extending as a streak up inner surface; middle and hind femora fringed on lower edge with delicate little hairs, which could scarcely be called cilia; costa without an enlargement at tip of first vein; bend in last section of fourth vein distinctly before its middle. Otherwise about as in the male. Middle tibiae with one bristle below, their basitarsi without a bristle above.

Redescribed from several males and females taken in the following localities: Illinois, July and Aug.; Mount Washington, New Hampshire; Shelby, Indiana, May 24; Sandusky, Ohio, August 20; Olcott, New York, July 10; Lancaster, New York, May 5; East Aurora, New York, June 9; Toronto, Ontario, July 15.

Type locality.—Illinois. Osten Sacken reports it from western New York, Wheeler from Wisconsin, Aldrich from Michigan and New Jersey, Chagnon from Montreal, Canada, Mrs. Slosson from New Hampshire.

No. 46. DOLICHOPUS ALACER, new species.

Male.—Length 3.25-3.75 mm.; of wing 3-3.75 mm. Face rather narrow, silvery white, narrowest in the middle. Front shining green. Antennae wholly black; third joint scarcely as long as wide, rounded at tip. Proboscis and palpi brownish yellow. Orbital cilia wholly black.

Thorax bright shining green, sometimes with blue or coppery reflection; pleurae and coxae with white pollen. Abdomen green with black incisures and abundant white pollen, which is thickest on its sides. Hypopygium black; its lamellae (fig. 46a) of moderate size, somewhat triangular in outline, rather truncate at outer end, white with narrow black border on apical margin, which extends a short distance on lower edge, ending abruptly and expanding on upper corner so as to make the upper angle all black, a little jagged and bristly on apical margin.

Coxae black with yellow tips. Fore coxae with minute black hairs on the anterior surface and the usual bristles at tip. Femora black, often metallic green, their tips yellow. Middle and hindfemora each with one preapical bristle, the latter ciliate on lower inner edge with sparse, delicate, whitish hairs for most of their length, the longest of these hairs about two-thirds as long as the width of the femora. Tibiae yellow; posterior pair with black at tip for one-fifth their length, scarcely thickened, the glabrous stripe between the rows of large bristles narrow but distinct; there are about four bristles in each of the rows. Fore tarsi a little longer than

their tibiae, first joint as long as the three succeeding joints taken together; fourth and fifth joints of about equal length; third a little longer than the fourth, yellow, a little darker from the tip of the first joint. Middle tarsi equal to their tibiae in length, black from the tip of first joint. Hind tarsi one and a fourth times as long as their tibiae, black. Calypters and halteres yellow, the former with delicate black cilia; these cilia appear whitish in certain lights and there are always some of the hairs that are pale yellow or white.

Wings (fig. 46) a little grayish; costa not enlarged at tip of first vein; last section of fourth vein bent beyond its basal third; hind margin of wing not indented at tip of fifth vein, evenly rounded, the anal angle being nearly obsolete.

Female.—Face as wide as the front, but still not very wide for a female; silvery white; hind femora not ciliated, but with a row of very delicate little hairs on lower inner edge; anal angle of wing slightly more prominent than in the male. Otherwise about as in the male. Middle tibiae with one not very large bristle below, their basitarsi without a bristle above.

Described from 8 males and 7 females from Opelousas, Louisiana, March, April, and May (Pilate, collector), and Lafayette, Indiana, May 16, June 5, and Oct. 6 (all from the collection of J. M. Aldrich); 1 male and 2 females from Slidell, Louisiana, July 2-6 (J. S. Hine).

Type.—Male, Cat. No. 23000, U.S.N.M., from Lafavette, Indiana.

No. 47. DOLICHOPUS PARTITUS Melander and Brues.

Dolichopus partitus Melander and Brues, Biol. Bull., vol. 1, 1900, p. 135, fig.

Male.—Length 5-5.5 mm.; of wing the same. Face wide, a little less than half as wide as long, yellowish brown, paler below the transverse ridge, at each end of which is a white dot. Front violet, more green around the edges. Antennae (fig. 47a) wholly black; third joint a little longer than wide, oval. Orbital cilia wholly black; however, there are always a few yellowish bristles near the proboscis and in one specimen seven of the lower cilia are also yellowish.

Thorax dark green or brownish green with thick brown pollen (in the specimens before me there is no "cupreous vitta" mentioned by Melander and Brues in their description, but this is almost always a variable character in this genus); pleurae dulled with gray pollen. Abdomen green, the incisures narrowly black and edged with coppery reflections. Hypopygium black; its lamellae rather large, oval, still somewhat triangular in outline as they narrow into the stem, whitish in the center, shading into yellow and then into black, often infuscated on more than half their surface, more yellow near the stem, jagged and bristly at apex, otherwise fringed with blackish hairs.

Coxae black; anterior pair with gray pollen and black hairs on their front surface. Femora black with vellow tips, the vellow on the middle ones extends toward their base on the upper edge nearly to the middle. Middle and hind femora each with a row of three or four bristles ending in the usual preapical bristle (these are often broken off so as to leave only one or two); hind femora ciliated below with delicate brown hairs, the longest of which are fully as long as the width of the femora, these hairs extend the whole length of the lower inner edge but are very short at the base and longest near the tip. Fore and middle tibiae vellow: hind tibiae thickened, black, yellow at base for a distance about equal to half the length of their basitarsus and with a vellowish line extending their entire length just inside of the inner row of large bristles, the two rows of bristles on upper surface, although of only ordinary length, are inserted rather close together, there being about 10 or 12 in each row, the glabrous stripe between them distinct. Fore tarsi one and a half times as long as their tibiae, the first two joints taken together about equal to the tibia in length; fifth joint nearly as long as fourth, third a little longer than fourth. Fore and middle tarsi infuscated from their base, becoming black at half their length, the latter about one and a fourth times as long as their tibiae. Hind tarsi wholly black, about one and a half times as long as their tibiae. Calvpters and halteres vellow, the former with black cilia.

Wings (fig. 47) grayish; there are brown clouds along the cross-vein and the adjoining portions of the fourth and fifth veins, on the bend of the last section of fourth vein and a rather well-defined spot extending from a point opposite the cross-vein to tip of third vein and from the costa to the third vein; costa with an elongated enlargement at tip of first vein; last section of fourth vein bent at or before its basal third; hind margin of wing a little indented at tip of fifth vein, widest point of wing just back of this notch; anal angle prominent.

Female.—Face a little wider than in the male and more brownish; fore tarsi shorter, about one and a fourth times as long as their tibiae; fore and middle basitarsi more yellow; hind tibiae not much thickened; hind femora not ciliated, wings brown in front of third vein from the root to the tip of third vein, cross-vein clouded about as in the male; costa not enlarged; otherwise about as in the male. Middle tibiae with one bristle below, their basitarsi without a bristle above.

Redescribed from 3 males and 1 female from Colorado; 1 of the males was taken by J. M. Aldrich at Marshall Pass, Colorado, July 28, at 10,856 feet elevation, the other specimens were taken by C. F. Baker.

Type locality.—Colorado.

Another female taken at Marshall Pass, Colorado, July 28, 1908, has scarcely a trace of the brown clouding on the wings, except on the veins, but no doubt it belongs to the same species—probably a little immature.

No. 48. DOLICHOPUS SETIFER Loew.

Dolichopus setifer Loew, Neue Beitr., vol. 8, 1862, p. 12; N. Amer. Dipt., pt. 2, 1864, p. 30.—Aldrich, Kans. Univ. Quart., vol. 2, 1893, p. 156.—Melander and Brues, Biol. Bull., vol. 1, 1900, p. 148.—Johnson, Insects of N. J., 1909, p. 756.

Male.—Length 4-4.2 mm.; of wing 3.75-4 mm. Face narrow, silvery white. Front bright shining green. Antennae (fig. 48a) wholly black; third joint about as long as wide, nearly round in outline, but obtusely pointed at tip; lateral and inferior orbital cilia silvery white, the lower cilia flattened.

Thorax bright shining green, sometimes with traces of two coppery vittae at the front edge of the dorsum (in one specimen from Niagara Falls, New York, there are two violet vittae extending nearly to the middle of the dorsum); pleurae dulled with white pollen. Abdomen shining green with slight bronze reflections and black incisures; the white pollen on its sides abundant. Hypopygium black; its lamellae of moderate size, somewhat triangular in outline, white with the apical border black, a little jagged and bristly at lower corner, with delicate, mostly pale hairs on upper and lower edges.

Coxae black with dark yellowish brown tips; fore and middle coxae with white hairs on their anterior surface, the former with the usual black bristles at tip, still they appear almost white in certain lights in many specimens. Femora green with yellow tips. Middle and hind femora each with one preapical bristle, the latter with long black cilia below, which appear white when viewed in certain lights; the longest of these cilia twice as long as the width of the femora. and middle tibiae yellow; hind tibiae thickened, yellow on upper edge for about two-thirds their length, black at tip, on the sides more brown at base or almost black, becoming black at half their length, their bristles long and numerous. Fore tarsi slightly longer than their tibiae, brown; first joint about as long as the three succeeding joints taken together. Middle tarsi about as long as their tibiae, black from the tip of the first joint. Hind tarsi wholly black, the first joint with numerous large bristles on upper surface. Calypters and halteres yellow, cilia of the former pale yellow.

Wings (fig. 48) nearly hyaline with a black spot at tip, reaching from the tip of the second vein to the apex of the wing and about as wide as the length of the cross-vein; costa a little enlarged at tip of first vein; last section of fourth vein a little bent before its middle; hind margin of wing not indented at tip of fifth vein; anal angle obsolete, the wing being narrowed at base; root of wing yellow.

Female.—Face as wide as the front; cilia of lower orbit less flattened than in the male but silvery white; hind basitarsi with only the usual number of bristles; hind tibiae more yellow than in the male and the wings more grayish and without a spot at tip; otherwise about as in the male; middle tibiae with one large bristle below, their basitarsi without a bristle above.

Redescribed from numerous males and females. In the Aldrich collection are specimens from Battle Creek, Michigan; Lake Mills, Wisconsin, Aug., 1893; Ithaca, New York, July, 1901; Waubamic, Parry Sound, Ontario, June 10. I have taken it in Erie County, New York, from July 2 to Aug. 16; at Niagara Falls, New York, June 9, and at Niagara Falls, Ontario, Sept. 28.

Type localities.—District of Columbia and Trenton Falls, New York. Osten Sacken reports it from Newport, Rhode Island. Johnson, Insects of New Jersey, 1909, from several places, taken from May 16 to September 9.

No. 49. DOLICHOPUS RETINENS, new species.

Male.—Length 5-5.5 mm.; of wing 4.5-4.75 mm. Face rather narrow, white, tinged with yellow, more strongly so on upper portion. Front dark shining green. Antennae wholly black; third joint somewhat conical in outline, a little longer than wide, pointed at tip. Orbital cilia wholly black.

Thorax dark shining green, sometimes with brassy reflections on the dorsum; pleurae a little dulled with white pollen. Abdomen shining green with black incisures and bronze reflections, which are mostly on the hind margins of the segments, the white pollen on its sides forms large spots on the lower edges of the segments. Hypopygium black; its lamellae rather large, somewhat elliptical, but irregular in outline, about two-thirds as wide as long, white with narrow black border on apical, upper and lower margins; jagged and bristly at apex, especially on lower corner, otherwise fringed with black hairs.

Coxae black with the tips a little yellowish; anterior pair with silvery pollen and very delicate, but not very short, yellowish hairs on the front surface. Femora black or green, fore and middle pairs broadly, the hind pair narrowly yellow at tip. Middle and hind femora each with one preapical bristle, the latter with pale cilia below, the longest hairs being about as long as the width of the femora, the hairs on their upper edge at base are nearly as long as the cilia below. Tibiae yellow; posterior pair black at tip for one third their length, a little thickened, especially at tip, the glabrous stripe on upper surface distinct and extending over the inner side; they have a row of slender bristles below; bristles of all the tibiae long and those of the anterior pair more numerous than usual. Fore tarsi (fig. 49) a little longer

than their tibiae, wholly pale yellow; first joint a little longer than the remaining four taken together and with a row of about ten black bristles on lower inner edge, which are nearly as long as the second joint, last four joints a little compressed and covered with silvery pollen, third and fourth each a little shorter than the preceding joint, fifth a little longer than the fourth. Middle tarsi as long as their tibiae, infuscated from the tip of the first joint, but scarcely black. Hind tarsi wholly deep black. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 49a) grayish; costa with a knot-like enlargement at tip of first vein; last section of fourth vein a little bent near its middle; hind margin of wing a little indented at tip of fifth vein, rather evenly and broadly rounded; anal angle a little prominent.

Female.—Face as broad as the front, white; hind femora without cilia; fore tarsi as long as their tibiae, darker yellow than in the male, sometimes the joints brown or blackish at tip, first joint with a row of hairs below which are as long as the width of the joint, last four joints without the silvery pollen found in the male; costa not enlarged at tip of first vein; otherwise about as in the male; middle tibiae with one bristle below, their basitarsi without a bristle above.

Described from 5 males and 5 females, taken at Lafayette, Indiana, June 3-8, 1915, by J. M. Aldrich.

Type.-Male, Cat. No. 23001, U.S.N.M.

No. 50. DOLICHOPUS REMIPES Wahlberg.

Dolichopus remipes Wahlberg, Vetensk. Akad. Handl., 1838, p. 20.—Zetterstedt, Dipt. Scand., vol. 2, p. 518.—Aldrich, Cat. N. Amer. Diptera, 1905, p. 304.

Male.—Length 5.2 mm.; of wing 5 mm. Face rather wide, its sides nearly parallel, long, extending down nearly to the lower corner of the eyes, silvery white. Front dark shining green. Antennae wholly black; third joint about as long as wide, somewhat orbicular in outline; arista nearly twice the length of the antennae. Lateral and inferior orbital cilia white, long and conspicuous below, about twelve of the upper cilia on each side black.

Thorax dark blue green; pleurae dulled with gray pollen; scutellum fringed with short yellow hairs; it sometimes has violet reflections, which extend upon the posterior part of the thorax. Abdomen green, with black incisures, second segment sometimes bluish, the white pollen on its sides abundant, the sides also have rather long white hair, Hypopygium black or testaceous, sometimes more yellowish toward the apex; its lamellae large, somewhat triangular, white with black border, very narrow except at inner angle where it is broad; a little jagged, bristly on lower corner, otherwise fringed with small hairs placed rather far apart.

Coxae black with vellow tips and white hairs; anterior pair with silvery pollen on the front surface, which is vellow nearly up to its middle. Femora black with green or blue reflections; middle pair with a few white hairs below; hind pair ciliate on lower inner edge with long white hairs, those toward the apex as long or longer than the width of the femora, those near the base shorter; middle and hind femora each with one preapical bristle. Tibiae vellow; posterior pair enlarged at tip and blackened from near their middle, the glabrous stripe above narrow and reaching from the base to beyond the middle. All femora and fore and middle tibiae and tarsi with white or silvery pollen on their anterior surface. Fore and middle tarsi a little longer than their tibiae and wholly yellow, except the extreme tips of all the joints which are blackish. Hind tarsi (fig. 50a) deep black, but appearing yellowish in certain lights, this yellow color being caused by minute yellow hairs; first joint with a few rather small bristles above, first and second joints of nearly equal length, the third, fourth, and fifth joints each about three-fourths as long as the preceding, slightly compressed and fringed above with long black hairs. Calypters and halteres yellow, the former with white cilia.

Wings (fig. 50) grayish with the costal edge brown as far as the third vein, fourth and fifth veins and the cross-vein margined with brownish; costa scarcely enlarged at tip of first vein; last section of fourth vein bent before its middle; hind margin of wing slightly indented at tip of fifth vein; anal angle rounded, not very prominent.

Female.—Face broad, white or silvery; hind tibiae yellow, black on apical third; hind tarsi plain, wholly black; all femora and fore and middle tibiae and tarsi with about the same silvery pollen on their front surface as is found in the male; fore and middle tarsi yellow with the tips of all their joints black; middle tibiae with one bristle below, their basitarsi without a bristle above; brown on the wings paler than in the male, and the anal angle more prominent; costa without an enlargement at tip of first vein.

Redescribed from 4 males and 3 females. One male was taken at Olympia, Washington, June 22, 1895, by Trevor Kincaid (now in the Aldrich coll.); 2 males and 1 female taken at Bar Harbor, Maine, July 26, 1919, on water-lily pads, by C. W. Johnson; 1 pair taken at Cranmore, Wisconsin, July 12, 1909, by C. W. Hooker; I took a female at Toronto, Ontario, July 12, 1918.

This species seems to be found on plants that float on the water, such as water lilies; they are never or seldom found on erect plants, either growing in the water or along the sides of the ponds.

Location of type unknown; presumed to be in Stockholm. It was described from northern Europe.

No. 51, DOLICHOPUS SEDULUS, new species.

Male.—Length, 4-5 mm.; of wing, the same. 'Face wide, covered with dark vellowish pollen, which is sometimes a little golden, at others more brownish. Front shining green, antennae black, first joint very slightly yellowish on the lower apical angle (this color may be caused by pollen); third joint not longer than wide, somewhat orbicular in outline, obtusely pointed at tip. Lateral and inferior orbital cilia white; there are about six black cilia on each side above.

Thorax almost coppery brown on the anterior portion, more green posteriorly, with rather thick brown pollen on the front two-thirds of the dorsum, which leaves shining vittae or spots; pleurae dulled with white pollen. Abdomen green with narrow black incisures and bronze reflections, wholly covered with white pollen, which is thickest on its sides. Hypopygium black; its lamellae (fig. 51a) moderately large, somewhat orbicular in outline, but tapering into the stem and . a little flattened at tip, white with rather narrow black border on apical margin, where they are jagged and bristly, fringed above with delicate but long black hairs.

Coxae black with vellow tips; anterior pair with white pollen and little black hairs on the front surface. Fore femora black, shading into yellow at tip; middle femora mostly yellowish, black at base and along upper and lower edges for a greater or less distance, with one preapical bristle and often a smaller one a little nearer the base; hind femora black, their inner surface more yellow, with one preapical bristle, without cilia below but fringed with rather long black hairs on upper edge. Tibiae vellow; posterior pair black at tip for nearly one-fourth their length, slightly thickened, a more or less distinct brown line on the inner side of central portion, the glabrous stripe on upper surface broad, extending from the outer row of bristles, well upon the inner surface so as to include the inner row of bristles. Fore tarsi a little longer than their tibiae, black from the tip of the first joint, this joint fully as long as the three succeeding taken together; fourth and fifth joints of nearly equal length, third a little longer. Middle tarsi about one and a fourth times as long as their tibiae, black from the tip of the first joint. Hind tarsi wholly black, about one and a third times as long as their tibiae. Calypters and halteres yellow, the former with very black cilia.

Wings (fig. 51) grayish, slightly darker in front; costa with a slight knot-like enlargement at tip of first vein, still tapering a little to its tip; last section of fourth vein a little bent at or just beyond its basal third, sometimes it is a little more sharply bent and bears a stump of a vein at the posterior angle of the bend; hind margin of wing scarcely indented at tip of fifth vein; wing of rather parallel width, the anal angle being prominent.

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Female.—Face wide, brownish gray to whitish in color; hind tibiae not thickened, without the brown stripe on inner surface, and the glabrous stripe on upper surface not conspicuous; wings with the anal angle less prominent, although of somewhat equal width. Otherwise about as in the male. Middle tibiae with one large bristle below, their basitarsi without a bristle above, but with several very small ones below.

Described from 6 males and 2 females; 5 of the males and the 2 females were taken at Moscow, Idaho, June 19, 1900; 1 male was taken at Lafayette, Indiana, August 13. All were taken by J. M. Aldrich.

Type.—Male, Cat. No. 23002, U.S.N.M., from Idaho.

No. 52. DOLICHOPUS GROENLANDICUS Zetterstedt.

Dolichopus groenlandicus Zetterstedt, Diptera Scand., vol. 2, 1843, p. 528.

Male.—Length 4.3-4.8 mm.; of wing 4.8-5 mm. Face moderately wide, yellowish brown. Front bronze brown or more or less greenish, not very bright. Antennae wholly black; third joint rather large, a little longer than wide, oval, rounded at tip. Palpi black. Orbital cilia wholly black.

Thorax bronze brown with slight green reflections, dulled with brown pollen on the dorsum; pleurae with grayish pollen. Abdomen bronze brown, or green with dark bronze reflections, the white pollen on its sides abundant. Hypopygium black; its lamellae (fig. 52a) of moderate size, somewhat quadrilateral in outline, brown but not very dark, the edges only slightly darker, jagged and bristly on apical margin, fringed above with rather long and slender brown hairs.

Coxae black; anterior pair with conspicuous little black hairs. Fore femora blackish on basal half, yellow apically, the black variable in extent. Middle femora yellow with a black or brownish streak on lower edge at base, with one preapical bristle in front and a small bristle close to tip on posterior side. Hind femora black with extreme tip yellow, with one preapical bristle, the hair on upper edge at base long, not ciliated below. Tibiae yellow; middle pair with one long bristle below; posterior pair a little thickened, black at tip for one fourth their length, with strong bristles, the glabrous stripe on upper surface distinct, inner side with a wide glabrous stripe, which reaches the whole width at basal third, where there is a short brown streak. Fore tarsi one and a fourth times as long as their tibiae, black from the tip of the first joint, this joint as long as the three following taken together, fourth and fifth of nearly equal length, third a very little longer than the fourth. Middle tarsi one and a third times as long as their tibiae, black from the tip of the first joint, which is dark yellow and without a bristle above. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 52) rather dark grayish; costa with a small knot-like enlargement at tip of first vein; last section of fourth vein bent before its middle, nearly straight and parallel with third beyond the bend, the third being only slightly bent backward at tip; hind margin of wing not indented at tip of fifth vein; anal angle of wing moderately prominent.

Female.—Agrees with the male in general color and in the formation of the wings and legs; the face is wide and dark grayish; the third antennal joint is a little pointed at tip.

Redescribed from 4 males and 1 female; 1 of the males was taken in Colorado, by Baker; all the other specimens were taken in Labrador; 1 male at Ungava Bay, July 29, by L. M. Turner (National Museum); the others, from the collection of C. W. Johnson, were taken at Nain, August 18, by Owen Bryant.

There seems to be no doubt of the determination of these specimens. Type.—In the University of Lund, Sweden.

No. 53. DOLICHOPUS INCONGRUUS Wheeler.

Dolichopus incongruus WHEELER, Psyche, vol. 5, 1890, p. 338.

Male.—Length 4.5-5 mm.; of wing 4.25-4.75 mm. Face narrow, silvery white. Front green or blue-green, shining. Antennae wholly black; third joint three times as long as wide, pointed at tip. Proboscis and palpi black with black hairs. Orbital cilia wholly black.

Thorax bright green, shining, dorsum with blue and bronze reflections, the latter forming more or less distinct vittae; pleurae more black, dulled with brownish gray pollen. Abdomen shining green with blue or bronze reflections. Hypopygium black; its lamellae (fig. 53a) small, somewhat triangular in outline with the apex rounded and not jagged, fringed with delicate hairs, whitish with a black border.

Coxae black with yellow tips; anterior pair with white pollen and little black hairs on the front side. Basal two-thirds of fore femora black, apical third yellow. Middle femora yellow, sometimes a little blackened at base on upper and lower edges. Hind femora black with yellow tips, not ciliated below, with a few longer hairs at base on upper edge. Middle and hind femora each with one preapical bristle; tibiae yellow, posterior pair a little stouter than the others, with the apical third black, the black sometimes extending nearly to their middle on inner side, not sharply defined and with an elongated brown spot at basal third of inner side; the glabrous stripe on upper surface distinct and extending inside of the inner row of

bristles. Fore tarsi brownish yellow, as long as their tibiae, the basitarsi as long as the remaining four joints taken together, fourth joint very slightly shorter than the fifth. Middle tarsi one and a fourth times as long as their tibiae, black from the tip of the first joint. Hind tarsi one and a third times as long as their tibiae, wholly deep black. Calypters and halteres yellow, the cilia of the former black (Doctor Wheeler states in his description that these cilia are yellow, but our specimens agree with his description in all other points and as there are some long yellow hairs back of the black cilia he probably saw these, the true cilia having been broken off, or perhaps there are specimens with the cilia all yellowish).

Wirgs (fig. 53) grayish; costa only a little enlarged at tip of first vein; last section of fourth vein bent at its basal third; hind margin of wing not or scarcely indented at tip of fifth vein, evenly rounded, the anal angle being rounded, not prominent.

Female.—I have no female which seems to be long here, although two of those I have placed with the next species (remus) were taken with males of this species, still as they have two preapical bristles on the middle and hind femora they seem to belong with remus the male of which has two bristles while incongruus only has one, this should be the best character to separate the females by.

Redescribed from 5 males; 1 taken at Colden, New York, May 31; 1 at Ellis, New York, June 13; and 2 at Protection, New York, June 16; 1 at South Wales, New York, June 23.

Type.—In American Museum of Natural History.

No. 54. DOLICHOPUS REMUS, new species.

Male.—Length 4 mm.; of wing the same. Face narrow, white, a little wider and more yellowish on upper part. Front bright shining green. Antennae wholly black; third joint large, nearly three times as long as wide, somewhat elliptical in outline, but nearly straight above and rounded below, pointed at tip. Orbital cilia wholly black.

Thorax dark green, very shining, with more or less coppery reflections which form vittae on the anterior edge of the dorsum, where there is a little white pollen; pleurae more blackish with grayish pollen. Abdomen dark shining green with black incisures and coppery reflections. Hypopygium black; its lameliae (fig. 54a) very small, oval, whitish with a black border, fringed with black hairs, not jagged at tip.

Coxae black with yellow tips; anterior pair with white pollen and little black hairs on the front surface. Fore femora with basal two thirds black; middle femora yellow with about basal fourth blackish; hind femora black with the tip narrowly yellow, nearly bare below. Middle and hind femora each with two preapical bristles, placed one

before the other. Tibiae yellow; posterior pair black at tip for onesixth their length, a little stouter than the others, slightly swollen below before their middle, at which point there is a brown spot on inner surface: the glabrous stripe between the large bristles not well marked, but just inside of the inner row of bristles is a narrow glabrous stripe extending three-fourths their length and expanding to include the brown spot mentioned above; bristles of the tibiae rather short. Fore tarsi about as long as their tibiae, their joints of decreasing length, vellowish, a little darker toward their tips. Middle tarsi (fig. 54c) one and a half times as long as their tibiae (fig. 54b), black from the tip of the first joint; second, third, and fourth joints each a little shorter than the one preceding it, fourth a little compressed, widest in the middle; fifth joint short, about one-half as long as the fourth. Hind tarsi one and one-third times as long as their tibiae, deep black. Calypters and halteres yellow, cilia of the former black.

Wings (fig. 54) grayish, very slightly tinged with brown in front of third vein; of somewhat equal width; costs with a small knot-like enlargement at tip of first vein; last section of fourth vein a little bent just before basal third; hind margin of wing scarcely indented at tip of fifth vein, anal angle prominent.

Female.—Face wide, grayish white; third antennal joint a little longer than wide, pointed at tip, rather large for a female; fore and middle femora black with their tips rather broadly yellow; middle tibiae and tarsi black, the former with one large and one small bristle below, the latter a little longer than their tibiae; first joint about as long as the three succeeding joints taken together and without a bristle above; fore tarsi mostly blackish; bend in last section of fourth vein at its basal third, being a little farther from the cross-vein than in the male; wings more broadly rounded on hind margin than in the male and more strongly tinged with brown in front of third vein; costa without an enlargement at tip of first vein.

Described from 4 males and 5 females. One male was taken at Algonquin, Illinois (Nason); 1 at Ithaca, New York; 1 at Portage, New York, July 1; and 1 at Toronto, Ontario, July 4. One female was taken at Gowanda, New York, June 7; 1 at East Aurora, New York, June 9; 2 at Protection, New York, June 16; and 1 at Ridgeway, Ontario, July 15.

Type.—Male, Cat. No. 23003, U.S.N.M., from Ithaca, New York. This species is very much like incongruus Wheeler, having the same large and elongated third antennal joint. The legs of the two species are colored alike and both have the same small lamellae which are shaped and colored about alike, they also have the bend in the last section of fourth vein at or just before its basal third; but this species

differs in having the fourth joint of middle tarsi compressed and widened, in the middle and hind femora each having two preapical bristles, and in having the posterior tibiae narrowly black at tip. The next species, adultus is even more closely related to remus than is incongruus, as it has the same narrow black tip to hind tibiae, they differ only in the plain middle tarsi of adultus, and in its having only one preapical bristle, it differs from incongruus in the narrow black tip of the hind tibiae.

No. 55. DOLICHOPUS ADULTUS, new species.

Male.—Length 5 mm.; of wing 4.5 mm. Face rather wide, narrowed a little below, silvery white, a little grayish. Front blue green, sometimes with violet reflections at vertex. Antennae (fig. 55b) wholly black; third joint large, three times as long as wide, pointed at tip; arista about as long as the antennae, inserted at apical third of upper edge. Orbital cilia wholly black.

Thorax dark green with coppery reflections; dorsum very shining; pleurae dulled with gray pollen. Abdomen a lighter green with black incisures, dulled with white pollen, which forms large spots on the sides of the segments. Hypopygium black with coppery reflections on basal part; its lamellae (fig. 55a) small, dark brownish to whitish with the edges and tip black, fringed with black hairs, somewhat triangular in outline with a rather sharp point at outer corner.

Coxae black with the tips narrowly yellow; anterior pair with white pollen and little black hairs on the front surface. Fore and hind femora black with the tips of the former broadly, of the latter narrowly, yellow. Middle femora black at base, becoming yellow at about basal third on upper and lower edges, the yellow extending nearer the base on the sides. Middle and hind femora each with one preapical bristle, the latter not ciliated below. Tibiae vellow; posterior pair black at tip for less than one-fifth their length; a slight swelling just before their middle can be seen when viewed from above, and the tips are a little thickened; the glabrous stripe on upper edge is wide, reaching narrowly inside of the inner row of bristles. Lower surface of middle tibiae with one bristle near apical third and one near basal third. Fore and middle tarsi black from the tip of the first joint, the former about as long as their tibiae, fourth and fifth joints of nearly equal length, third a little longer, the middle tarsi one and a fourth times as long as their tibiae. Hind tarsi wholly black. Calypters pale yellow with black cilia. Halteres yellow, their stems darker.

Wings (fig. 55) grayish, slightly tinged with brown in front of second vein; root of wing yellow; costa very slightly enlarged at tip of first vein; last section of fourth vein bent at basal third, beyond which it is very nearly parallel with third vein; hind margin of wing

slightly indented at tip of fifth vein, rather evenly rounded; anal angle rather prominent.

Female.—Face nearly as broad as the front, white, a little silvery; front a beautiful violet, narrowly edged with green along the orbits; legs and tarsi black with knees, trochanters, fore and middle tibiae and base of fore tarsi yellowish; wings strongly tinged with brown in front of fourth vein and along the cross-vein.

Described from 1 pair from Lewiston, New York, May 31; 1 female from Colden, New York, May 31; 1 female from East Aurora, New York, May 24; 1 female from Hamburg, New York, June 6; 1 male from Framingham, Massachusetts, May 28; and 1 male from Ocean County, New Jersey.

Type.—Male, Cat. No. 23004, U.S.N.M., from Lewiston, New York.

No. 56. DOLICHOPUS CALIFORNICUS, new species.

Male.—Length 5 mm.; of wing the same. Face rather wide, its sides nearly parallel, rounded below, reaching down to the lower corner of the eyes, silvery white. Front shining green. Antennae black with a large yellowish lobe on lower inner corner of first joint; second joint a little yellowish on inner side; third joint about as long as wide, pointed at tip; arista longer than the antennae, inserted a little above the point of the third joint. Upper orbital cilia black, lateral and inferior cilia silvery white, becoming flattened and very conspiguous below.

Thorax dark green, sometimes more blue, with a little white pollen along the anterior edge of the dorsum; pleurae dulled with white pollen. Abdomen green with coppery reflections on the hind margins of the segments, incisures blackish, sides of segments with spots of white pollen. Hypopygium black; its lamellae (fig. 56a) rather large, somewhat oval in outline, whitish with black border, jagged and bristly bn apical margin, otherwise fringed with rather long hairs.

Coxae black; anterior pair with yellow tips, the front surface nearly bare with a few black hairs along inner edge, and covered with white pollen. Anterior femora black with the apical third yellow. Middle femora black at base, sometimes for nearly half their length, yellow apically, with one preapical bristle. Hind femora black on basal half or more above, on the lower edge the yellow sometimes extends nearly to the base, fringed on upper outer edge with long bristle-like hairs which increase in length and size and end in the usual preapical bristle. Fore and middle tibiae yellow. Hind tibiae black, thickened, a little fusiform, with a glabrous stripe above between the rows of large bristles. All femora and tibiae with more or less white pollen. Fore tarsi about as long as their tibiae, very slightly com-

pressed. Middle tarsi a little longer than their tibiae. Middle and hind tarsi black from the tip of the first joint. Hind tarsi wholly black. Calypters and halteres yellow, the former with white cilia.

Wings (fig. 56) slightly tinged with gray; costa with a knotlike enlargement at tip of first vein; last section of fourth vein rather sharply bent at its basal third; tips of third and fourth veins rather far apart; hind margin of wing deeply notched at tip of fifth vein; anal angle rounded, not very prominent.

Described from 4 males; 1 was taken at Kanaka Bay, San Juan Island, Washington, May 31, 1906, by J. M. Aldrich; 2 I took at Sacramento, California, June 4, 1915, and 1 taken by E. P. Van Duzee, at Crystal Lakes, San Mateo County, California, June 25, 1916.

Type.—Male, Cat. No. 23005. U.S.N.M., from Sacramento, Cali-

fornia.

No. 57. DOLICHOPUS UMBROSUS, new species.

Male.—Length, 4.7 mm.; of wing, 4.5 mm. Face wide, silvery white, slightly tinged with yellow on upper part. Front dark shining green. Antennae wholly black; third joint large, twice as long as wide, pointed at tip, nearly straight above, rounded below to the tip; arista a little longer than the antennae, inserted just beyond the middle of the third joint. Orbital cilia wholly black.

Thorax dark green; anterior part of dorsum dull in type specimen, apparently from brown pollen, posterior part and scutellum shining; pleurae dulled with whitish pollen. Abdomen dark green with slight coppery reflections, incisures black. Hypopygium black, very small; its lamellae dark yellowish, edged with black and fringed with short black hairs, somewhat oval in outline, but narrowed into the stem; the hypopygium (fig. 57a) including its lamellae only reaching the posterior ventral edge of the second abdominal segment.

Coxae black with silvery pollen, their extreme tips and trochanters yellow; fore coxae with black hairs on the anterior surface. Fore and hind femora black, the former broadly, the latter narrowly yellow at tip. Middle femora black at base, dark yellow at apex, the yellow extending nearly to the base on the sides, but the black reaching three-fourths their length on lower edge and shading into brownish yellow. Middle and hind femora each with two prespical bristles, placed one before the other, the latter not ciliated below, but with a row of rather long hairs on lower outer edge. yellow; posterior pair not thickened, black for one-fourth their length, the black not well defined, the glabrous stripe on upper edge distinct. Fore tarsi a little longer than their tibiae, dark yellow, blackish above from the tip of the first joint. Middle and hind tarsi wholly black; the former about one and a half times as long as their tibiae, with fourth joint very slightly flattened, more than twice as long as fifth, their basitarsi without a bristle above. Calypters pale yellow with black cilia, which are decidedly yellow in certain lights; halteres yellow.

Wings (fig. 57) very slightly tinged with brown in front; veins dark-brown, yellow at the root of the wings; costa black, not enlarged at tip of first vein; last section of fourth vein only a little bent near basal fourth, from which point the third and fourth veins approach each other and are nearly straight, their tips rather close together; hind margin of wing slightly indented at tip of fifth vein; anal angle rounded, still rather prominent.

Female.—Face wider than that of the male, third antennal joint about as long as wide; trochanters brown or black; middle femora black with yellow tip; hind femora with one preapical bristle; fore and middle tarsi wholly yellow; hind tibiae blackened at tip for about one-third their length. Wings as in the male, except that the bend in fourth vein is beyond basal third and the tips of third and fourth veins are a little farther apart.

It may prove that this is a different species from the male described above, as it has but one preapical bristle and the middle tarsi are yellow. Still the wing venation would indicate that they belong together.

Described from one male and one female taken in Polk County, Wisconsin, by C. F. Baker in July.

Tupe.—Male, Cat. No. 23006, U.S.N.M.

No. 58. DOLICHOPUS LATICORNIS Loew.

Dolichopus laticornis LOEW, Neue Beitr., vol. 8, 1861, p. 12; Mon. N. Amer-Diptera, pt. 2, 1864, p. 29.—Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 7.-MELANDER and BRUES, Biol. Bull., vol. 1, 1900, p. 148.

Male.—Length, 4.2-5 mm.; of wing, 3.5-4 mm. Face rather wide, scarcely narrowed below, silvery white, sometimes a little yellowish just below the antennae. Front green or blue green. Antennae (fig. 58a) wholly black; third joint large, more than twice as long as wide, pointed at tip; arista inserted near apical third, about as long as the antennae. Orbital cilia wholly black.

Thorax green, sometimes with coppery reflections which form indistinct vittae on the dorsum; pleurae dulled with gray pollen. Abdomen dark green, sometimes with coppery reflections, its sutures narrowly black; the white pollen on its sides forms large spots on the lower edges of the segments. Hypogyium black; its lamellae of moderate size, somewhat triangular in outline, rather acutely pointed at tip, white with a very narrow dark border which is more distinct near the apex, not jagged on apical margin, fringed with small dark hairs.

Coxae black with yellow tips and white pollen; anterior pair with minute white hairs on the front surface. Fore and hind femora black with yellow tips; middle femora yellow, blackened at base for one-fourth to one-third their length. Middle and hind femora each with one preapical bristle, the latter not ciliated below. Tibiae yellow; posterior pair black at tip for one-fifth their length, this black rather sharply defined, the glabrous stripe on upper surface broad, extending well upon the inner side and including the inner row of large bristles; they are slightly swollen on inner side near the middle. Fore tarsi as long as their tibiae, mostly yellow, but darker from the tip of the first joint. Middle tarsi about equal to their tibiae in length, black from the tip of the first joint. Calypters and halteres pale yellow, the former with white cilia.

Wings (fig. 58) a little grayish; costa with a very small knotlike enlargment at tip of first vein; bend in last section of fourth vein small and near its basal third; beyond this bend the third and fourth veins are parallel and straight; hind margin of wing not indented at tip of fifth vein; anal angle rounded, not very prominent, the wings of somewhat parallel width.

Female.—Face wide, silvery white; front sometimes violet; third antennal joint only a little longer than wide; middle femora black with apical fourth yellow; hind tibiae black at tip for one-third to three-fourths of their length, and on inner side nearly to the base; sometimes black with the base yellow on upper edge to near the middle; the black is never well defined; cilia of calypters usually more or less black but with some yellow or white hairs, sometimes wholly white.

Redescribed from 4 males and 3 females; 1 pair was taken at Battle Creek, Michigan, by J. M. Aldrich; 1 male at New Bedford, Massachusetts, May 17 (Hough); 1 female at Toronto, Ontario, May 16 (all these are in the collection of J. M. Aldrich); 2 males and 1 female at Beverly, Massachusetts, June 1, in the United States National Museum.

Type.—In Museum of Comparative Zoology, Cambridge, Massachusetts.

No. 59. DOLICHOPUS NODIPENNIS, new species.

Male.—Length, 5.2 mm.; of wing, 5 mm. Face of moderate width, silvery white. Front dark green, shining. Antennae (fig. 59a) wholly black; third joint large, nearly twice as long as wide, pointed at tip, arista inserted a little beyond the middle, longer than the antennae.

Thorax dark green, shining, sometimes with coppery reflections on lateral edges and along the central line; pleurae more black, dulled with gray pollen. Abdomen dark green with coppery reflections near the hind margins of the segments, incisures narrowly black. Hypopygium black; its lamellae of moderate size, somewhat triangular in outline, but rounded at tip, whitish or yellowish, the edge scarcely darker, not jagged or bristly, fringed with delicate brown hairs.

Coxae black with yellow tips and thin silvery pollen, anterior pair with a few minute white hairs on the front surface. Fore and hind femora black with tips and extreme base yellow. Middle femora and their trochanters yellow. Middle and hind femora each with one preapical bristle. Fore and middle tibiae and tarsi wholly yellow, the latter scarcely darker at tip. Fore tarsi scarcely as long as their tibise, fourth joint shorter than fifth. Middle tarsi about one and a fourth times as long as their tibiae, the tibiae being longer than their Hind tibiae mostly black, upper edge yellowish at base for about one-fourth their length and shading into the black, the glabrous stripe on upper surface rather wide, extending inside of the inner row of large bristles for a short distance near basal third; their hairs long and dense, especially on apical two-thirds. Hind tarsi shining black, with stiff black hairs. Calypters, their cilia, and the halteres pale vellow.

Wings (fig. 59) grayish; costa with a very distinct enlargement at tip of first vein; last section of fourth vein only a little bent at its basal third, from which point the third and fourth veins gradually converge, still their tips are not very close together; hind margin of wing a little notched at tip of fifth vein, back of this notch it widens a little; anal angle rather prominent.

Female.—Face wide, grayish white; all femora black with extreme base and tips yellow; fore tibiae and tarsi yellow; middle tibiae and tarsi black with the articulations yellowish; hind tibiae and tarsi wholly black; notch at tip of fifth vein not as conspicuous as in the male; costa without an enlargement at tip of first vein; wings tinged with brownish in front and along the veins; cilia of the calypters more or less black.

Described from 3 males and 3 females. Two males and 1 female were taken at Montreal, Quebec, June 3 and 23; 1 pair were taken by me at East Aurora, New York, June 2; and 1 female at Ridgeway, Ontario, July 15.

Type.—Male, Cat. No. 23007, U.S.N.M., from East Aurora, New York.

This differs from the male of laticornis Loew in having the hind tibiae much darker, clothed with much longer hair, and its glabrous stripe narrower; the middle femora wholly yellow, not black at base; costal enlargement at tip of first vein more conspicuous; third and fourth veins distinctly convergent at their tips. The females differ in having the middle tibiae black with extreme tips yellow, and the hind tibiae wholly black; the third and fourth veins convergent as in the male, while in laticornis they are parallel at tip.

No. 60. DOLICHOPUS SOLIDUS, new species.

Male.—Length 4.75 mm.; of wing 4.5 mm. Face wide, covered with white pollen, which has a slight yellowish tinge. Front shining green. Antennae black, normal; third joint a little longer than wide, somewhat pointed at tip. Lateral and inferior orbital cilia whitish, about seven of the upper cilia on each side black.

Thorax dark green, somewhat dulled with brown pollen on the dorsum; pleurae dulled with white pollen. Abdomen green with coppery reflections, black incisures and white pollen; the latter forms large spots on the sides on the segments. Hypopygium black; its lamellae of moderate size, oval but narrowing into the stem, whitish with a black border, which is rather broad on apical margin, very narrow on upper and lower edges, but extending to the stem, somewhat jagged and bristly at apex, fringed above with delicate hairs.

Coxae black with their extreme tips yellowish; anterior surface of fore coxae with white pollen and little hairs which appear to be partly black and partly white. Fore femora black with their tips broadly yellow. Middle femora yellow with a blackish line below on basal two-thirds. Hind femora yellow with their upper surface black nearly to the tip. Middle and hind femora each with one preapical bristle, the latter ciliate on lower inner edge with yellow hairs which have a blackish appearance in certain lights and are scarcely as long as the width of the femora. Fore and middle tibiae yellow. Hind tibiae yellow at base becoming black at tip, the apical half being mostly black. Fore and middle tarsi black from the tip of the first joint (the apical joints of both are missing in the type). Hind basitarsi black (other joints missing). Calypters and halteres yellow, the former with black cilia.

Wings (fig. 60) tinged with brownish; costa with an elongate, but small enlargement at tip of first vein; last section of fourth vein bent at its middle; hind margin of wing scarcely indented at tip of fifth vein; anal angle rather prominent.

Described from 1 male taken on the Alaska-Yukon boundary, longitude 141°; latitude 69° 10′, August 14–17, 1912, by J. M. Jessup. Type.—Male, Cat. No. 23008, U.S.N.M.

No. 61. DOLICHOPUS BRYANTI, new species.

Male.—Length 4.2 mm.; of wing 3.7 mm. Face wide, narrower below, silvery white. Front dark shining green. Antennae wholly black; third joint about as long as wide, conical in outline; arista rather short. Lower half of the orbital cilia white, upper half mostly black.

Thorax dark green, somewhat dulled with brown pollen on the dorsum. Abdomen green, the white pollen of the sides extends over

the dorsum. Hypopygium black; its lamellae rather small, somewhat triangular in outline but rounded at tip, whitish with black apical border, not much longer than wide.

Coxae black, scarcely yellow at tip. Fore femora black with their tips broadly yellow. Middle and hind femora yellow, each with one preapical bristle; middle pair narrowly black on the lower edge of their basal half or more; posterior pair black at tip for a considerable distance, but the yellow extending nearly to their tips on lower edge and ciliated on lower inner edge with short yellow hairs (sometimes appearing blackish), which are about one-third as long as the width of the femora. Fore and middle tibiae yellowish; posterior tibiae black, a little yellowish at base, the black shading into the yellow, slightly thickened. Fore tarsi one and a fourth times as long as their tibiae; fore and middle tarsi blackened from the tip of the first joint; middle basitarsi without a bristle above. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 61) grayish; costa with a small knot-like enlargement at tip of first vein; last section of fourth vein very slightly bent near its middle; hind margin of wing evenly rounded, the anal angle being only slightly developed.

Described from 2 males from Labrador taken by Owen Bryant; 1 at Great Caribou Island, July 27; the other at Nain, July 18; 1 female at Ungava Bay, Labrador, July 29; and 1 pair at Hopedale. Labrador, taken by Packard.

Holotype in the collection of C. W. Johnson, taken on Great Caribou Island, Labrador.

Allotype.—Female, Cat. No. 23009, U.S.N.M., from Ungava Bay (L. M. Turner).

No. 62. DOLICHOPUS AMNICOLA Melander and Brues.

Hygroceleuthus amnicola Melander and Brues, Biol. Bull., vol 1, p. 130, fig.

Male.—Length 4.5-5 mm.; of wing 4.5 mm. Face rather wide, pale golden yellow, long and rounded below. Front green with bronze reflections in the center. Antennae long; first joint long, yellow, usually black above; second joint black on upper half or twothirds, yellow below; third joint black, longer than wide, somewhat oval but a little pointed at tip. Proboscis black. Palpi yellow with black hairs. Lateral and inferior orbital cilia yellow, about twelve of the upper cilia on each side black.

Thorax black with bronze reflections, which sometimes form narrow vittae on the dorsum, the anterior portion of which has considerable yellowish gray pollen; pelurae dulled with white pollen. Abdomen green with coppery reflections, tergum with white pollen which is scarcely thicker on the sides. Hypopygium black; its lamellae of

moderate size, somewhat oval in outline, yellowish with a black border on the apical and upper margins, the rounded apex jagged and bristly, fringed above with bristle-like hairs, below with delicate yellow hairs.

Coxae black with yellow tips; anterior pair with green reflections, white pollen and rather long black hairs on the front surface. Fore femora black on basal two-thirds or three-fourths, yellow at tip. Middle and hind femora yellow, usually a little blackened at base below, the former with one preapical bristle, the latter with a row of three or four bristles of increasing length, ending in the usual preapical bristle, nearly bare below. Tibiae yellow; fore and middle ones sometimes a little darkened at tip, the former with four large bristles on lower outer edge, the latter with two large bristles below; posterior tibiae black at tip for one-fifth to one-fourth their length, a little thickened and with a row of about five bristles below, which are nearly as large as those above. Fore tarsi a little longer than their tibiae, blackened from the tip of the first joint, which is as long as the three succeeding joints taken together. Middle tarsi only a little longer than their tibiae, first two joints yellow, last three black. still the third is sometimes yellow for half its length; middle basitarsi without a bristle above. Hind tarsi black, sometimes with the extreme base of the first joint yellowish. Calypters and halteres vellow, the former with black cilia.

Wings dark grayish, tinged with yellowish gray in front of third vein and narrowly along all the posterior veins; costa scarcely enlarged at tip of first vein; last section of fourth vein sharply bent before its middle, its tip a considerable distance before the apex of the wing; third vein bent backward so that it runs nearly parallel with the costa and forms a very acute angle with it at its tip, which is close to the tip of fourth vein; hind margin of wing indented at tip of fifth vein, and with a small sinus before the anal angle, which is prominent.

Female.—Face wider than in the male and more grayish; wings more evenly rounded on the hind margin; third vein not bent backward quite so much at tip, anal angle not quite so prominent and without the sinus before it, leaving the anal angle rounded, while in the male it is almost lobe-like; bristles of the legs and feet about as in the male.

Redescribed from 10 males and 15 females in the collection of J. M. Aldrich and taken at the following locations: Wells, Nevada, July 12; Oxford, Idaho, July 12 (Aldrich), and Pine Lake, southern California.

Type locality.—North Park, Colorado. J. M. Aldrich reports it from Cache County, Utah.

The above description agrees with the type specimen in the American Museum in New York, which is a female.

No. 63. DOLICHOPUS OPPORTUNUS, new species.

Male.—Length 5.3 mm.; of wing 5 mm. Face rather narrow, widening a little from the middle upward, silvery white. Front shining green. Antennae (fig. 63b) black, third joint small, but little longer than wide, rounded at tip. Orbital cilia wholly black.

Thorax green with slight coppery reflections on the sides of the dorsum; the carina running from the humeri to the root of the wings vellowish brown with a small reddish spot at the humeral end; pleurae more black with gray pollen. Abdomen green with coppery reflections, its incisures narrowly black; extreme lower edges of the dorsum on first and second segments more or less yellowish; the white pollen on its sides forms spots on the sides of the segments. Hypopygium black; its lamellae (fig. 63a) rather large, rounded, but narrowing into the stem, about as long as broad, whitish with a very narrow brown margin above and wider black border on the jagged apical margin, which is fringed with long bristlelike hairs.

Coxae black with yellow tips and silvery pollen; anterior pair with delicate white hairs on the front surface. Anterior femora black with their tips narrowly yellow. . Middle femora yellow, blackened at base on upper and lower edges for about one-third their length. Posterior femora yellow, with the tip and base black and narrowly black on upper edge. Middle and hind femora each with two preapical bristles, placed one before the other, the latter nearly bare below. All tibiae yellow; the posterior pair black at tip for onefifth their length, slightly thickened apically. Fore and middle tarsi about as long as their tibiae, brown from the tip of the first joint, the former with the joints of regularly decreasing length, first joint scarcely as long as the three succeeding joints taken together. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 63) tinged with brown, which color is deeper in front of the third vein, and with distinct clouds on the cross vein and at the bend in the fourth vein; costa scarcely thickened at tip of fifth vein: last section of fourth vein bent at its second fifth; beyond this bend the third and fourth veins are nearly parallel; hind margin of wing a little indented at tip of fifth vein, rather evenly rounded, the anal angle not being very prominent.

Female.—Face wide, white; third antennal joint nearly round in outline, still a little pointed at tip; fore coxae with white hairs on the anterior surface, mixed with a few black ones along the inner edge. Otherwise about as in the male. Middle tibiae with one bristle below, their basitarsi without a bristle above.

Described from 3 males and 4 females, taken by J. M. Aldrich at Hagerman, Idaho, July 1, 1900.

Type.—Male, Cat. No. 23010, U.S.N.M.

No. 64. DOLICHOPUS HUMILIS, new species.

Male.—Length 4.5 mm.; of wing 4.25 mm. Face wide, covered with whitish pollen. Front greenish black with a little brown pollen below. Antennae wholly black; first joint unusually long but not thickened; second joint rather long, slender at base, wider at tip; third joint but little longer than wide, scarcely as long as the first joint; rounded at tip; cilia of lower orbit white.

Thorax blackish, scarcely tinged with green, a little dulled with brown pollen. Abdomen dark green. Hypopygium black; its lamellae rather large, oval, whitish, with rather wide black margin.

Coxae black with yellow tips; anterior pair with white hairs on front surface, and a few black ones along inner edge. Anterior femora black at base, becoming yellow toward the apex; (middle tibiae missing, but likely to be yellow); hind femora yellowish, darker at base. Tibiae yellow; posterior pair with their tips black for one-fifth their length and a little swollen. Fore tarsi about as long as their tibiae, black from the tip of the first joint, fourth and fifth joints of about equal length; hind tarsi wholly black. Calypters and halteres yellow, the former with white cilia.

Wings a little grayish; costa with a large elongated enlargement at tip of first vein; last section of fourth vein with a rather sharp bend at its basal third; hind margin of wing scarcely indented at tip of fifth vein; anal angle rather prominent; outer part of wing very wide, the wing being narrowed at base.

Described from 1 male taken on the Alaska-Yukon boundary, longitude 141°; latitude 69° 20′, August 4-8, 1912, by J. M. Jessup.

This species is remarkable for the long, slender first antennal joint, which separates it from all related species known to me.

Type.—Male, Cat. No. 23011, U.S.N.M.

No. 65. DOLICHOPUS BREVICAUDA, new species.

Male.—Length 4 r.m.; of wing 3.5 mm. Face wide, only a little narrowed below, white. Front shining green. Antennae (fig. 65b) wholly black; third joint not longer than wide, a little pointed at tip. Lateral and inferior orbital cilia whitish, about ten of the upper cilia on each side black.

Thorax shining green with bronze reflections; pleurae a little dulled with white pollen. Abdomen green with coppery reflections and white pollen, which is rather thick on its sides. Hypopygium black, small, not much longer than its small lamellae (fig. 65a) which are yellowish with rather narrow black border on apical margin, they are somewhat triangular in outline, but with the upper angle rounded.

Coxae black with their extreme tips yellowish; anterior pair with minute black hairs on the front surface. Fore femora black with

yellow tips; middle ones black at base, gradually becoming yellow, the apical half being mostly yellowish; hind femora black on upper half, more yellowish on lower half. Middle and hind femora each with one preapical bristle, the latter not ciliate below. Tibiae yellow; middle ones slightly darkened at tip, with one long slender bristle below; posterior pair a little thickened at tip, black apically for one fourth their length, which is rather sharply defined. Fore tarsi black fron the tip of the first joint, one and a fourth times as long as their tibiae, first joint about as long as the three following joints taken together, fourth joint shorter than fifth. Middle tarsi black from the middle of the first joint, about one and a fourth times as long as their tibiae, their basitarsi without a bristle above. Hind tarsi wholly black. Calypters and halteres yellow, the cilia of the former black.

Wings (fig. 65) grayish; costa not enlarged at tip of first vein; last section of fourth vein a little bent just before its middle; hind margin of wing not indented at tip of fifth vein; evenly rounded; the anal angle not prominent.

Described from 1 male from Mount Washington, New Hampshire, on August 16, 1916, taken by C. W. Johnson, at an elevation of 5,000 feet.

Type.—In the collection of the Boston Society of Natural History.

No. 66. DOLICHOPUS VARIPES Coquillett.

Dolichopus varipes Coquillett, Proc. Wash. Acad. Sci., vol. 2, 1900, p. 425.— ALDRICH, Cat. N. Amer. Diptera, 1905, p. 305.

Male.—Length, 4 mm.; of wing, the same. Face rather narrow: palpi and face covered with dense, vellowish pollen. Front shining green. Antennae black with the first two joints vellow on lower edge: third joint only a little longer than wide, obtuse at tip, orbital cilia black and strong above, pale and short on lateral orbit, a few of the lower ones long and vellow.

Thorax green, dorsum somewhat dulled with gray pollen, which leaves the posterior part and a central vitta shining; pleurae more blackish, dulled with gray pollen. Abdomen dark green. Hypopygium black; its lamellae of moderate size, somewhat ovate, whitish with a black border, jagged and bristly on apical margin, fringed above with black hairs.

Fore coxae wholly yellow with silvery white pollen, front surface with little black hairs, except on the upper outer part where the hairs are very minute and white. Middle and hind coxae black, their tips and the trochanters yellow. Forward middle femora yellow, the latter with a black or brown streak below. Hind femora black with their extreme tips yellow. Middle and hind femora each with one

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preapical bristle, the latter without cilia below. Tibiae yellow; posterior pair with their tips blackened; the glabrous stripe on upper surface wide, extending upon the inner side, not quite reaching the base, but reaching the tip as a yellow streak across the black; it is divided by the inner row of large bristles which is continued to the tip by little black hairs. Fore tarsi a little longer than their tibiae, yellow, infuscated at tip. Middle tarsi (fig. 66a) one and a fourth times as long as their tibiae; first three joints slender, yellow, fourth and fifth joints black, compressed, densely fringed with black hairs above; fourth joint about as long as third, fifth about half as long, somewhat orbicular in outline but nearly straight below. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 66) grayish; costa not enlarged at tip of first vein; last section of fourth vein a little bent beyond its basal third; anal angle very prominent; hind margin of wing scarcely indented at tip of fifth vein, but with a sinus from this point to the anal angle.

Female.—Face wide as the front, silvery white; third antennal joint about as long as wide, otherwise the antennae are about as in the male; legs and feet as in the male except that the middle tarsi are plain and only a little longer than their tibiae; hind margin of wing without a sinus and the anal angle not quite so prominent as in the male. The fore coxae are wholly yellow; middle tibiae with one bristle below, their basitarsi without a bristle above.

Redescribed from 1 male and 3 females taken by J. M. Aldrich; 1 pair at Craig's Mountain, Idaho; 2 females at Emigration Canyon, Utah, 1 on July 8, 1911, the other on July 21, 1917, at 7,000 feet elevation.

The type specimen in the United States National Museum, No. 5236, is from Popof Island, Alaska, taken July 8, 1899; it is in poor condition; it appears to be a male, but I could not see the hypopygium and the middle tarsi are broken off; with this stands a female from the same place, taken July 10, and also a specimen taken on the top of the Las Vegas Range, New Mexico, June 28 (T. D. A. Cockerell).

No. 67. DOLICHOPUS FLAVILACERTUS, new species.

Male.—Length 4-4.5 mm.; of wing 3.5-3.75 mm. Face very narrow, golden yellow, more silvery near the proboscis, front dark green. First antennal joint wholly yellow, second and third joints black (fig. 67a), third nearly orbicular in outline but slightly pointed at tip. Orbital cilia wholly black.

Thorax green with more or less distinct coppery reflections, which sometimes form stripes along the rows of acrostichal bristles; pleurae dulled with gray pollen. Abdomen dark green with large

spots of white pollen on the sides of the segments and narrow black incisures. Hypopygium black; its lamellae of moderate size, somewhat oval in outline but narrowed into the stem and quite pointed at tip, whitish or yellowish with a narrow brown border and fringed with brown hairs; the hook-shaped inner appendages are prominent, vellow, and nearly as long as the lamellae.

Fore coxae vellow in front for more than half their length, black at base, the front surface with black hairs, but with these are many delicate yellow ones. Middle and hind coxae black with vellow tips. Fore and middle femora yellow, the latter with a black line at base below, and a small black spot above. Hind femora black with extreme tips yellow, ciliated on lower inner edge with black hairs, which are about half as long as the width of the femora. Middle and hind femora each with one preapical bristle. Fore and middle tibiae yellow; hind tibiae black, thickened, with an elongated spot of yellowish pollen on inner surface. Fore tarsi yellow at base, blackened from the tip of the second joint, about one and a fourth times as long as their tibiae, first joint as long as the remaining four taken together, third about three-fourths as long as second, last three joints a very little flattened. Middle tarsi about the length of their tibiae, black from the tip of the first joint. Hind tarsi wholly black. Calypters and halteres yellow, the former with

Wings (fig. 76) gray, brownish in front of the third vein; costa a little enlarged at tip of first vein, gradully tapering toward the tip; last section of fourth vein only a little bent just before its middle; third vein bent backward before the tip so that the tips of third and fourth veins are rather close together; hind margin of wing scarcely indented at tip of fifth vein; anal angle prominent; wings of rather equal width.

Female.—Face not very wide for a female, white; fore tarsi plain, black from the tip of the second joint; sometimes only the last two joints are black; hind tibiae thick for a female, black, with one bristle below, their basitarsi without a bristle above; anal angle of wing not as prominent as in the male.

Described from 6 specimens. One pair taken at Beltsville, Maryland, June 9, 1915, by W. L. McAtee; 1 male from the same location taken by N. Banks; 1 male taken at Fall River, Massachusetts, June 8, 1909, by N. S. Easton; 1 male at Acto, New Jersey, June 15, 1893; 1 male at Barcroft, Virginia, June 7, 1912; and 1 female taken by me at Kearney, Ontario, July 9, 1909.

Type.—Male, Cat. No. 23012, U.S.N.M., from Beltsville, Maryland.

No. 68. DOLICHOPUS RUPESTRIS Haliday.

Dolichopus rupestris Haliday, Ent. Mag., vol. 1, 1833, p. 164.—Schiner, Fauna Austr., vol. 1, 1862, p. 222.

Dolichopus festinans ZETTERSTEDT, Insecta Lapp., 1840, p. 708.—Coquillett, Proc. Wash. Acad. Sci., vol. 2, p. 424.

Dolichopus fuscimanus ZETTERSTEDT, Dipt. Scand., vol. 2, 1843, pp. 507, 510.

Male.—Length, 5 mm.; of wing, the same. Face wide, a little wider at widest point than the width of the third antennal joint; yellowish brown, more whitish on the lower portion. Front bronze brown, shining. Antennae wholly black; third joint a little longer than wide, ovate, still a little pointed at tip. Palpi brownish. Orbital cilia wholly black.

Thorax bronze brown, dulled with rather thick brown pollen; pleurae more blackish, dulled with gray pollen. Abdomen dark green, the last two segments more bronze brown; the white pollen of its sides extends over the dorsum and leaves a median line and the hind margins of the segments blackish. Hypopygium black; its lamellae of moderate size, somewhat quadrilateral in outline, more or less brownish with a black border, jagged and bristly on apical margin, otherwise fringed with black hairs.

Fore coxae black, sometimes more or less reddish, as if immature, clothed on the anterior surface with little black hairs; middle and hind coxae almost wholly black, femora yellow. Middle and hind femora each with one preapical bristle; posterior pair with a olack or brown spot on upper surface at tip, nearly bare below; tibiae yellow; hind tibiae a little swollen on inner side at basal third and at tip, black at tip for one-sixth their length; the glabrous stripe on upper surface wide and distinct, reaching their entire length and extending on to the inner side on the swollen portion; sometimes this swollen portion has a reddish brown streak. Fore and middle tarsi one and a fourth times as long as their tibiae, black from the tip of the first joint, first joint of the former as long as the three succeeding joints taken together, second joint a little longer than the third, fourth and fifth joints of nearly equal length. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 68) dark grayish; costa with a knotlike enlargement at tip of first vein; last section of fourth vein a little bent just before its middle; hind margin of wing not indented at tip of fifth vein; tips of third and fourth veins widely separated; anal angle of wing rather prominent.

Female.—Face wider and more yellowish or whitish than in the male; hind tibiae not swollen on inner side; costa without an enlargement; color of the thorax more greenish; otherwise about as in the male. Middle tibiae with one bristle below, their basitarsi without a bristle above, but with a rather large bristle below near the middle and several small ones; the male also has these bristles on the lower

surface of the middle basitarsi, the largest of these is larger than is found on the lower surface of most, if not any other, of our species.

Redescribed from several males and females in the United States National Museum; they were taken on Popoff Island, Alaska, July 8, and St. Paul Island, Alaska, August 11, by T. Kincaid; and 2 pairs taken by J. S. Hine, at Katmai, Alaska, August.

Location of type unknown. It is European.

No. 69. DOLICHOPUS FUCATUS, new speci

Male.—Length, 5 mm.; of wing, 4 mm. Face of moderate width, silvery white. Front shining green with coppery reflections in the center. Antennae wholly black; third joint about as long as wide, somewhat orbicular in outline, but slightly pointed at tip. Lateral and inferior orbital cilia yellowish, a few of the upper ones black.

Thorax shining green with slight copperv reflections, which form indications of two vittae on the anterior edge of the dorsum; pleurae dulled with white pollen. Abdomen shining green with black incisures and coppery reflections; the white pollen on the sides not very Hypopygium black; its lamellae (fig. 69a) rather large, somewhat triangular in outline, but a little rounded at apex, white with a narrow black border, jagged and bristly at lower corner; otherwise fringed with black hairs.

Coxae black; anterior pair yellow at tip for about half their length on the front side; middle and hind pairs narrowly yellow at tip. Femora yellow. Middle and hind femora each with one preapical bristle, the latter black at tip as far as the preapical bristle, without cilia below. Tibiae yellow; posterior pair black at tip for one-fifth their length, the glabrous stripe on upper surface distinct, occupying the space between the rows of large bristles, which are rather widely separated; fore and middle tarsi a little longer than their tibiae, black from the tip of the first joint, the former with the first joint nearly as long as the remaining four joints taken together; second joint slightly longer than the third; third and fifth of nearly equal length; fourth slightly shorter. Hind tarsi wholly black. Middle tibia with one bristle below, its basitarsus without a bristle above. Calvoters and halteres yellow, the former with yellow cilia; still some of these cilia appear brown or blackish in certain lights.

Wings (fig. 69) gravish, strongly tinged with brown in front of second vein; costa scarcely enlarged at tip of first vein; last section of fourth vein a little bent at its middle; hind margin of wing slightly indented at tip of fifth vein; anal angle not at all prominent, the wing being narrowed at base.

Described from 1 male taken on Mount Constitution, Orcas Island, Washington, July 7, 1905, by J. M. Aldrich.

Type.—Male, Cat. No. 23013, U.S.N.M.

No. 70. DOLICHOPUS APHELES Melander and Brues.

Dolichopus apheles MELANDER and BRUES, Biol. Bull., vol. 1, 1900, p. 144, fig. 3.

Male.—Length 4-5 mm.; of wing 4 mm. Face wide, yellowish gray or almost whitish. Front blue green, a little dulled with gray pollen. Antennae black; lower edge of first joint more or less reddish; third joint about as long as wide, subtriangular, a little pointed at tip. Palpi dark yellow. Lateral and inferior orbital cilia yellowish, about six of the upper cilia on each side black.

Thorax green, more shining and bluish posteriorly, the anterior half of the dorsum dulled with brownish pollen; pleurae dulled with white pollen. Abdomen green with black incisures, hind margins of segments coppery; the white pollen of its sides abundant and extending over the dorsum. Hypopygium black; its lamellae (fig. 70a) rather small, only a little longer than wide, oval but narrowing into the stem, whitish with a narrow black border on apical and upper margins, jagged and bristled at apex, fringed above with delicate, rather long, dark hairs.

Fore coxae yellow, with a round black spot at base on outer surface, front side with white pollen and conspicuous black hairs. Middle and hind coxae black with yellow tips. Femora yellow; middle and hind femora each with one preapical bristle, the latter black at tip on upper edge as far as the preapical bristle, without cilia below. Tibiae yellow; posterior pair scarcely thicker than the others, black at tip for one-fifth their length. Middle tibiae with one bristle below, their basitarsi without a bristle above. Fore and middle tarsi a little longer than their tibiae, black from the tip, sometimes from the middle of the first joint, the front ones with the first joint as long as the three following joints taken together, fourth and fifth of equal length, third a little longer than fourth. Hind tarsi wholly black, scarcely one and a fourth times as long as their tibiae. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 70) grayish, tinged with brown in front of third vein; costa not enlarged at tip of first vein; last section of fourth vein a little bent beyond its basal third, but before its middle; hind margin of wing not indented at tip of fifth vein; anal angle rounded, not very prominent.

Redescribed from the type specimen in the American Museum of Natural History in New York City, which was taken at Milwaukee, Wisconsin; and 1 male taken at Battle Creek, Michigan, by J. M. Aldrich.

No. 71. DOLICHOPUS AFFLUENS, new species.

Male.—Length 4.2-5 mm.; of wing 4 mm. Face of moderate width, silvery white. Front dark shining green. Antennae wholly black; third joint about as long as wide, slightly pointed at tip.

Lateral and inferior orbital cilia whitish, about eight of the upper cilia on each side black.

Thorax green with more or less coppery reflections; dorsum with a very little brown pollen which can be seen only when it is viewed obliquely; pleurae dulled with white pollen. Abdomen shining green with coppery reflections, which are more conspicuous on the hind margins of the segments; the white pollen on its sides rather abundant. Hypopygium black; its lamellae (fig. 71a) rather large, somewhat triangular but rounded on upper corner, nearly as wide as long, white, with a narrow black border on the apical margin, which is jagged and bristly.

Coxae black with yellow tips; anterior pair with the yellow extending to the middle on the front surface, which is covered with silvery white pollen and little black hairs; the hairs on the outer edge of the front side are minute and white. Femora yellow; anterior pair brown on the upper surface. Middle and hind femora each with one preapical bristle, the latter black at tip as far as the preapical bristle, without cilia below; the little hairs on both inner and outer surface wholly black. Tibiae yellow; posterior pair a little thickened, black for about one-fourth their length, the glabrous stripe between the rows of bristles on upper surface broad. Fore and middle tarsi a little longer than their tibiae, black from the tip of the first joint, the former with the first joint nearly as long as the remaining four joints taken together, third and fifth joints of equal length, fourth slightly shorter. Hind tarsi wholly black, about one and a fourth times as long as their tibiae. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 71) grayish, tinged with brown in front from the tip of the first vein back as far as the third vein; costa scarcely thickened at tip of first vein; last section of fourth vein a little bent before its middle; hind margin of wing slightly indented at tip of fifth vein, rather evenly rounded, the anal angle not being much developed.

Female.—Differs from the male in having the face wide, white but not silvery; the fore femora are brown above as in the male, the middle tibiae have one bristle below, their basitarsi are without a bristle above.

Described from 8 males and 1 female, taken on Mount Constitution, Orcas Island, Washington, July 7, 1905, by J. M. Aldrich.

Type.—Male, Cat. No. 23014, U.S.N.M.

This species differs from apheles Melander and Brues in having the face narrow and silvery (it is wide and yellowish gray in apheles) and in having the hypopygial lamellae larger and the fore femora brown above. From discolor, new species, it differs in having the fore coxae largely black and the fore femora brown above, in discolor the fore coxae are mostly vellow and the fore femora not at all darkened above. From fucatus, new species, it differs in having black cilia on the calypters and the brown on upper edge of fore femora, fucatus has yellow cilia and the fore femora wholly yellow. It differs from sincerus Melander and subdirectus, new variety, in having the wings brownish in front of third vein, front green and the tips of hind tibiae sharply black; in these other two forms the wings are almost hyaline, front violet and the hind tibiae yellowish on inner side almost to the tip, more black on the outer side, but the black shading into the yellow.

No. 72. DOLICHOPUS DISCOLOR, new species.

Male.—Length 4.5-5 mm.; of wing 4-4.2 mm. Face rather wide, silvery white. Front shining green with more or less violet reflections. Antennae black; first joint yellow below; third joint but little longer than wide, somewhat conical in outline. Palpi yellow. Lateral and inferior orbital cilia yellowish, a few of the upper cilia black.

Thorax green, dorsum with grayish brown pollen, which leaves the posterior part and a median vitta shining, often with bronze or blue reflections; pleurae dulled with white pollen. Abdomen green with black incisures and coppery reflections; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black; its lamellae (fig. 72a) of moderate size, short oval, or somewhat quadrate in outline, being cut off rather abruptly at apex and the upper angle at base rising abruptly from the stem, white with rather broad black border on apical and upper margins, jagged and bristly at apex, fringed above with rather long brown hairs.

Fore coxae yellow, infuscated at base, sometimes the outer side is black for half their length, sometimes it has only a black spot at base, anterior surface with conspicuous black hairs. Middle and hind coxae black with yellow tips. Femora yellow; middle and hind ones each with one preapical bristle, the latter black at tip on upper edge as far as the preapical bristle, the lower inner edge has a row of minute yellow hairs, not ciliated. Tibiae yellow, posterior pair scarcely thickened, black at tip for about one-fifth their length, the glabrous stripe on upper surface distinct. Fore and middle tarsi a little longer than their tibiae, black from the tip of the first joint, the former with the first joint as long as the three following joints taken together, fourth and fifth of equal length, Hind tarsi wholly black, one and a third times as long as their tibiae. Calpyters and halteres yellow, the former with black cilia.

Wings (fig. 72) grayish, strongly tinged with brown in front of third vein; costa not enlarged at tip of first vein; last section of fourth vein bent just beyond its basal third; hind margin of wing scarcely indented at tip of fifth vein; rather evenly rounded; anal angle moderately prominent, but rounded.

Female.—Face wide, covered with white pollen; thorax and front femora more blue than in the male; fore coxae, hind femora, and hind tibiae about as in the male; fore and middle tarsi slightly shorter than in the male. Middle tibiae with one bristle below, their basitarsi without a bristle above.

Described from many males and females which were taken as follows: At Algonquin, Illinois, June 4 (Nason); by me at Lewiston, New York, May 30; Erie County, New York, May 30 to August 4; Tonawanda, New York, August 4; Fort Erie, Ontario, June 20; Toronto, Ontario, August 12; also 1 female, Turtle Mountains, near Bottineau, North Dakota, June 21. (Aldrich.)

This species differs from sincerus Melander by having the fore coxae mostly yellow, only infuscated at base, in sincerus they are almost wholly black with the tip narrowly yellow; the hypopygial lamellae are larger and wider at base here, the fore part of the wing brownish and the face silvery white.

Type.—Male, Cat. No. 23015, U.S.N.M., from Erie County, New York.

No. 73. DOLICHOPUS SINCERUS Melander.

Dolichopus sincerus Melander, Canadian Ent., vol. 32, 1900, p. 136, figs.

Male.—Length 3.75-4.5 mm.; of wing 3-4 mm. Face rather wide, silvery white, sometimes quite yellowish on upper three-fourths. Front dark shining green, sometimes violet (Melander says "brassygreen"). Antennae wholly black; third joint a little longer than wide, somewhat oval in outline but rather pointed at tip. Palpi dark yellow with white pollen. Lateral and inferior orbital cilia yellowish, the black cilia descending about one-fourth the eye height.

Thorax dark shining green (Melander states "brassy-green, more cupreous along the sides and with two cupreous stripes in front"); pleurae dulled a little with grayish pollen. Abdomen green with black incisures, which are bordered with cupreous; the white pollen on its sides abundant, extending upon the dorsum. Hypopygium black; its lamellae of moderate size, somewhat triangular in outline, white with a broad black border on apical margin, which is jagged and bristly.

Coxae black with narrow yellow tips; anterior pair with white pollen and little black hairs on the front surface; the middle coxae usually have a few white hairs mixed with the black ones. Femora yellow. Middle and hind femora each with one preapical bristle, the latter black at tip, except below, as far as the preapical bristle; in the type specimen the black hairs on inner surface descend to the lower edge, not even leaving the usual glabrous stripe on lower edge, but in my

specimens there is a row of minute yellow hairs on lower inner edge. Tibiae yellow; posterior pair black at tip for about one-sixth their length; still the inner side is yellow almost to their tips; they are only a little thicker than the others. Fore tarsi about equal to their tibiae in length; infuscated from the tip of the first joint, which is about as long as the remaining four taken together; last three joints of about equal length. Middle tarsi a little longer than their tibiae, black from the tip of the first joint. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 73) grayish; costa a little enlarged at tip of first vein, gradually tapering to its tip; last section of fourth vein a little bent just before its middle; last section of fifth vein nearly three times as long as the cross vein; hind margin of wing scarcely indented at tip of fifth vein; anal angle of wing not very prominent, rounded.

Female.—Face wide, covered with whitish pollen; wings and feet about as in the male; the middle tibiae have three large bristles on lower anterior edge, their basitarsi without a bristle above.

Redescribed from a type specimen and 2 males which I took, one at Emsdale, Ontario, July 30, and the other at Scotia Junction, Ontario, July 31; 3 males and 3 females from the White Mountain region of New Hampshire, in the collection of J. M. Aldrich.

The type specimen, in the American Museum, was taken by Doctor Wheeler, in Price County, Wisconsin, Aug. 19, 1897.

Four females which I took at East Aurora, New York, June 15, seem to belong here, but they have tips of the hind tibiae black for one-fourth their length; a male taken by J. M. Aldrich at Olympia, Washington, I can not separate from the others.

No. 74. DOLICHOPUS SINCERUS, var. SUBDIRECTUS, new variety.

Male and female.—This form is so nearly like sincerus Melander that it would answer that description very well; it differs, however, in having the fore coxae more yellow at tips; costa scarcely at all enlarged at tip of first vein (in sincerus it is only a little thickened); the notch at tip of fifth vein is a little deeper; and the bend in the last section of fourth vein is very small and perhaps more exactly in its middle (fig. 74).

The nearly straight fourth vein is the only character which could be depended on to separate the two forms as far as I can see.

Described from 1 male and 2 females taken at Franconia, New Hampshire; 1 female taken at Woods Hole, Massachusetts; and 1 female from Monmouth, Maine, July 14, by C. A. Frost.

Holotype and allotype in the National Museum, taken at Woods Hole, Massachusetts.

Type.—Male, Cat. No. 23554, U.S.N.M.

No. 75. DOLICHOPUS GENUALIS, new species.

Male.—Length 4 mm.; of wing 3.7 mm. Face of moderate width, silvery white. Front shining green with bronze reflections. Antennae wholly black: third joint nearly twice as long as wide, obtuse at tip, arista inserted a little before the tip on the upper edge. Lower orbital cilia whitish, the upper cilia black.

Thorax green with slight bronze reflections; pleurae dulled with white pollen. Abdomen green with coppery reflections; the usual white pollen on its sides rather thin, but covering most of the sides of the segments. Hypopygium black; its lamellae (fig. 75a) of moderate size, triangular in outline, with the apical edge cut off obliquely so as to make the upper edge less than half as long as the lower and the lower point very acute; they are white with a very narrow black border on apical edge and with the acute point black; apparently not jagged but fringed on the apical margin with brown hairs.

Fore coxae vellow with a large black spot on the outer side at base, their anterior surface covered with little black hairs. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter black at tip, not ciliate below, the little black hairs on the outer side descending to the lower edge; but on the inner surface, however. there are a few delicate yellow hairs on the lower portion. Posterior tibiae black at tip for nearly one-fourth their length, only a little thickened. Fore tarsi a little longer than their tibiae, yellow, with the last two and a half joints black, first joint nearly as long as the remaining four taken together, fifth about as long as third and slightly compressed, fourth a little shorter than fifth. Middle tarsi one and a third times as long as their tibiae, black from the tip of the first joint. Hind tarsi wholly black. Calypters and halteres vellow, the former with black cilia.

Wings (fig. 75) gravish; costa not enlarged at tip of first vein: last section of fourth vein bent before its middle; third vein distinctly bent backward so as to approach the fourth at their tips; hind margin of wing scarcely indented at tip of fifth vein, rather evenly rounded, the anal angle not being very prominent.

Female.—Face wide, white; third antennal joint small, about as long as wide, the arista inserted just above the pointed tip; femora. tibiae, and wings about as in the male. Middle tibiae with one bristle below, their basitarsi without a bristle above.

Described from 1 male and 3 females. The male was taken at Moosehead, Maine, July 18; 1 female at Machias, Maine, July 20; 1 female at Fogo Island, Newfoundland, July 29, and the other female at Grand Lake, Newfoundland, July 25, 1906; and one female taken at Waubamic, Ontario, June 14, by H. S. Parish, and in the collection of A. L. Melander.

Type and allotype.—In the collection of the Boston Society of Natural History; the former was taken at Moosehead, Maine, and the latter at Fogo Island, Newfoundland.

The female from Machias, Maine, has on the fore coxae many little white hairs and the fore tarsi are black from the tip of the first joint; it is possible that it represents another species, but I think not.

No. 76. DOLICHOPUS PRAEUSTUS Loew.

Dolichopus praeustus LOEW, Mon. N. Amer. Diptera, pt. 2, 1864, p. 68.

Male.—Length, 5 mm.; of wing, 5.5 mm. Face rather wide, yellowish gray; front green, a little dulled with yellowish gray pollen. Antennae wholly black; third joint somewhat conical in outline, about as long as wide, obtusely pointed at tip. Lateral and inferior orbital cilia yellowish, about five of the upper cilia on each side black.

Thorax green with bronze reflections, which form a median vitta on the dorsum; dorsum dulled with yellowish-gray pollen, which is more abundant along the front; pleurae a little dulled with white pollen. Abdomen green with bronze reflections, in one specimen also with blue reflections; the white pollen on its sides forming large spots. Hypopygium black; its lamellae of moderate size, somewhat triangular in outline, not much rounded at apex; whitish with a rather narrow black border on apical margin, jagged and bristly at lower corner, otherwise the apical edge is fringed with delicate blackish hair; lower edge with a few delicate yellow hairs.

Fore coxae yellowish brown, more yellow at apex and along inner side (they have the appearance of not being fully colored), covered on their anterior surface with little yellowish brown hairs, which appear more black in certain lights. Middle and hind coxae black with their extreme tips yellow. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter with a large black spot above at tip, not ciliated but with a row of delicate little yellow hairs on lower inner edge.

Posterior tibiae only a little thickened, blackened at tip for about one-fourth their length, sometimes the black extends further toward the base on inner side; the glabrous stripe on upper surface broken up by the irregular bristles. Middle tibiae with one bristle below. Fore tarsi nearly one and a fourth times as long as their tibiae, infuscated from the tip of the first joint; first joint about as long as the three following joints taken together, fifth joint slightly longer than the fourth. Middle tarsi one and a fourth times as long as their tibiae, black from the tip of the first joint, their basitarsi without a bristle above. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia.

Wings rather long and of somewhat equal width; grayish, tinged slightly with yellow in front of third vein; costa scarcely thicker at

tip of first vein; last section of fourth vein scarcely bent, still with the suggestion of a bend before its middle, nearly parallel with third vein; hind margin of wing a little indented at tip of fifth vein, beyond which there is a small but distinct flattened lobe; anal angle rather prominent. Wing with a prominent blackish spot at tip, starting at tip of second vein, and extending back of fourth vein.

Redescribed from 2 male type specimens from Illinois.

Types.—In Museum of Comparative Zoology, Cambridge, Massachusetts.

No. 77. DOLICHOPUS OBSOLETUS, new species.

Male.—Length, 4.5 mm.; of wing, 3.5 mm. Face moderately wide and long, silvery white. Front shining blue green. Antennae black; first joint scarcely paler below; third joint rather large, short conical, about as long as wide, a little pointed at tip; proboscis and palpi black. Lateral and inferior orbital cilia whitish, the black cilia descend a little below the upper corner of the eye.

Thorax dark but shining green; pleurae dulled with white pollen. Abdomen dark green, shining, its incisures narrowly black; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black; its lamellae of moderate size, somewhat oval in outline, but tapering into the stem, only a little longer than wide. white with black border, jagged and bristly on apical margin, fringed with dark hairs above.

Fore coxae yellow, blackened a little at base, anterior surface with two rows of minute black hairs along inner edge, otherwise with pale hairs, covered with white pollen. Middle and hind coxae black with yellow tips. Femora and tibae yellow. Middle and hind femora each with one preapical bristle, the latter blackened above at tip as far as the preapical bristle, ciliated on the central half of lower edge with about ten yellow hairs which are longer than the width of the femora. Posterior tibiae a little thickened, black at tip for nearly one-third their length, brownish and glabrous for two-thirds their length on inner surface, sometimes the brown extends nearly to the Fore tarsi about one and a fourth times as long as their tibiae, black from the tip of the first joint, which is as long as the three following joints taken together. Middle tarsi black from the tip of the first joint, which is sometimes darkened almost to its base; it is without a bristle above. Hind tarsi wholly black. Middle tibiae with one bristle below. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 77) grayish, scarcely darker in front of third vein; costa with a very small knot-like enlargement at tip of first vein; last section of fourth vein bent a little before its middle; hind margin of wing slightly indented at tip of fifth vein, evenly rounded, the anal angle not being developed.

Described from 1 male taken at Franconia, New Hampshire, by Mrs. Slosson; and 1 male from Moosehead, Maine, July 18, taken by C. W. Johnson.

Type.—Male, Cat. No. 23016, U.S.N.M., from Franconia, New Hampshire.

No. 78. DOLICHOPUS TRISETOSUS, new species.

Male.—Length 4 mm.; of wing 3.5-4 mm. Face rather wide, yellowish. Front green or blue with violet reflections. Antennae (fig. 78a) black; first joint yellow below; third joint a little longer than wide, somewhat oval, but a little pointed at tip. Palpi yellow. Lateral and inferior orbital cilia yellowish white, about eight of the upper cilia on each side black.

Thorax green with blue or bronze reflections; dorsum with rather abundant brownish pollen, which is more gray along the front edge; pleurae dulled with white pollen. Abdomen green with black incisures and sometimes with coppery reflections; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black; its lamellae of moderate size, somewhat oval in outline, about one and a half times as long as wide, white with rather wide black border on upper and apical margins, jagged and bristly at apex, fringed above with rather long stout hairs and a little notched or jagged.

Fore coxae yellow with a black spot on outer surface at base, their anterior surface with white pollen and minute black hairs. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with a longitudinal row of three (sometimes only two) large bristles near the tip, the latter black at tip. except below, ciliated on lower inner edge of apical half or more with rather stout hairs, which are about three-fourths as long as the width of the femora; these hairs are usually deep black, but are sometimes reddish or yellow in certain lights. Posterior tibiae a little thickened. black at tip for one-fifth their length, the glabrous stripe on upper surface between the large bristles distinct; there is another glabrous stripe on inner surface which is wide near the base and becoming narrow at the tip of the tibiae; it is separated from the upper stripe by the inner row of bristles and a few small hairs between these bristles. Fore and middle tarsi a little longer than their tibiae, black from the tip of the first joint, the former with the first joint nearly as long as the three following taken together, fourth and fifth of nearly equal length, third only a little longer than fourth. Hind tarsi one and a third times as long as their tibiae, wholly black. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 78) grayish; costa with a small knotlike enlargement at tip of first vein; last section of fourth vein a little bent just before

its middle; hind margin of wing not indented at tip of fifth vein; wing of somewhat equal width; anal angle prominent and with indications of a flattened lobe at tip of sixth vein.

Female.—Face wide, white, a little tinged with yellow; middle and hind femora each with two, sometimes three bristles before their tips, the latter without cilia below, tarsi about as in the male; middle tibiae with one bristle below, their basitarsi without a bristle above; hind margin of wing rather evenly rounded, a little indented at tip of fifth vein; anal angle prominent, but without any indication of a lobe.

Described from 1 male and 9 females taken at Beverly, Massachusetts, June 4, 1869 (Riley, National Museum); 1 male, which I took at Colden, New York, May 31, 1914; 1 male taken at Sherborn, Massachusetts, May 30; and 1 male from New Brunswick, taken June 21, 1914, by J. D. Tothill.

Type.—Male, Cat. No. 23017, U.S.N.M., from Beverly, Massachusetts.

No. 79. DOLICHOPUS COMATUS Loew.

Dolichopus comatus LOEW, Neue Beitr., vol. 8, 1861, p. 23; Mon. N. Amer. Diptera, pt. 2, 1864, p. 69.—Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 14, pl. 2, fig. 25.—Melander and Brues, Biol. Bull., vol. 1, 1900, p. 148.

Male.—Length 2.5-4.2 mm.; of wing 2.5-4 mm. Face rather narrow, silver white. Front green, dulled with white pollen, especially along the orbits. Antennae wholly black; third joint one and a half times as long as wide, oval, rounded at tip. Lateral and inferior orbital cilia white, the lower ones flattened, about eight of the upper cilia on each side black. Proboscis and palpi blackish.

Thorax green with green reflections, which usually form a median vitta on the dorsum with a shining green or blue line on each side of it; dorsum a little dulled with almost invisible brownish pollen; pleurae dulled with white pollen. Abdomen green with narrow black incisures and coppery reflections; the white pollen on its sides extending upon the dorsum. Hypopygium black; its lamellae rather small, oval, a little longer than wide, white, with a narrow brown border on apical margin, fringed with delicate pale hairs, a few of those at apex brown.

Fore coxae yellow with a small blackish spot at base on outer side, anterior surface covered with silvery pollen and with little black hairs on inner edge. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter without cilia below, but with a row of delicate little yellow hairs on lower inner edge, and with a more or less conspicuous black spot at tip on upper edge. Posterior tibiae not thickened, black at tip for nearly one sixth their length. Middle tibiae (fig. 79) with a row of four long bristles on upper surface the longest of which is nearly three-fourths as long as the tibiae. Fore tarsi about one and a half times as long as their tibiae; first joint pale yellow, brown at extreme tip, slightly longer than the remaining four joints taken together, last four joints deep black, a little compressed, second and third of nearly equal length, fourth about as wide as long, fifth about as long as fourth but not as wide. Middle tarsi nearly one and three-fourths as long as their tibiae, black from the tip of the first joint, which has a row of eight or ten long, slender bristles on upper posterior edge, these are of decreasing length, the first being about half as long as the joint. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 79a) grayish; costa not enlarged at tip of first vein; last section of fourth vein a little bent near its middle; hind margin of wing scarcely indented at tip of fifth vein; nearly evenly rounded, the anal angle being rounded off.

Female.—Face wide, white; third antennal joint small, not longer than wide; front without white pollen; lower orbital cilia not at all flattened, not as white as in the male; palpi yellow; Fore coxae with the little black hairs extending over most of their anterior surface; middle tibiae with the bristles normal, their basitarsi without any bristle above; middle and hind tarsi one and a fourth times as long as their tibiae, blackened from the tip of the first joint, the former with the basitarsi about as long as the remaining four joints taken together, fifth joint slightly longer than fourth; bend in the last section of fourth vein slightly nearer the cross-vein than in the male.

Redescribed from numerous males and females from the following localities: Montgomery County, Pennsylvania, May 20 to July 24; Washington, District of Columbia, May 5; New Bedford and Woods Hole, Massachusetts; Lafayette, Indiana, May 4 to October 1; Michigan City, Indiana, August 18; Shelby, Indiana, May 24; Opelousas, Louisiana, March; New Jersey, several places, May to July; Western New York, May 26 to November 12; Cranmoor, Wisconsin, June 21; Fort Erie, Ontario, May 30; Black Creek, Ontario, July 24; Toronto, Ontario, July and August; Kearney, Ontario, July 26. College Station, Texas, March 16, 1908.

Type localities.—Pennsylvania, Maryland, District of Columbia. Aldrich reports it from Pennsylvania and New Jersey. Melander and Brues from Massachusetts, Illinois, and Wisconsin.

Type.—Museum of Comparative Zoology, Cambridge, Massachusetts.

No. 80. DOLICHOPUS VIRGA Coquillett.

Dolichopus virga Coquillett, Canadian Entomologist, vol. 42, 1910, p. 41.

Male.—Length 4.5 mm.; of wing the same. Face rather wide, silvery white. Front dark shining green. Antennae black; first joint very slightly vellowish on lower apical corner; third joint rather large, twice as long as wide, somewhat oval in outline, but obtusely pointed at tip. Lateral and inferior orbital cilia whitish, about six of the upper cilia black.

Thorax green, dorsum dulled with brown pollen and pleurae with white. Abdomen green with slight bronze reflections and black incisures; white pollen on its sides abundant and extending upon the Hypopygium black; its lamellae of moderate size. somewhat triangular in outline, apical margin straight and with an acute point at lower corner, whitish with a narrow black border on the oblique apical margin, which is fringed with rather long black hairs but not jagged.

Fore coxae yellow with a black spot on outer side at base, anterior surface covered with silvery pollen and little black hairs. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter with a blackish spot at tip on upper surface, nearly bare below. Middle tibiae without a bristle below; posterior tibiae black at tip for one-fifth their length. Fore tarsi (fig. 80a) about as long as their tipiae, black from the middle of the third joint; first two joints compressed, very thin but not widened, first as long as the remaining four taken together; last three joints compressed, of nearly equal length, third slightly widened at tip, fourth and fifth more (vertically) widened and fringed on either edge with little black hairs so as to form an oval tip to the tarsi. Middle tarsi a little longer than their tibiae, plack from the tip of the first joint. Hind tarsi wholly black. Calpyters and halteres vellow, the former with black cilia.

Wings (fig. 80) grayish, usually slightly darker in front of the third vein; costa not enlarged at tip of first vein; last section of fourth vein only a little bent near its middle; tips of third and fourth veins widely separated; hind margin of wing only slightly indented at tip of fifth vein, evenly rounded; anal angle rather prominent but rounded

Female.—Face wide; third antennal joint smaller than in the male, about one and a half times as long as wide; the black spot at tip of hind femora not as conspicuous; fore tarsi plain, a little longer than their tibiae, infuscated from the tip of the first joint. Middle tibiae with one bristle below, their basitarsi without a bristle above.

Redescribed from the type and 1 other male and 1 female in the National Museum collection, all taken at Manahawkin, New Jersey,

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Sept. 5, 1909, by H. S. Harbeck; 1 male taken at Eastport, Maine, June 30; 6 males and 3 females from Woods Hole, Massachusetts; and 2 males and 2 females from New Bedford, Massachusetts, May 20, 1896 (Hough).

Type.—Male, Cat. No. 12765, U.S.N.M.

No. 81. DOLICHOPUS BARYCNEMUS Coquillett.

Dolichopus barycnemus Coquillett, Harriman Alaska Exped., Insects, vol. 9, p. 28, 1904; Proc. Wash. Acad. Sci., vol. 20, 1904, p. 423.

Male.—Length 5.2 mm.; of wing 5 mm. Face wide for a male, yellowish white, purer white below. Front green, not very shining. Antennae black; first joint yellowish on lower edge; third joint only a little longer than wide, oval, rather rounded at tip. Lower orbital cilia yellowish; the black cilia descend nearly to the middle of the eye height.

Thorax green with very slight bronze reflections and abundant gray pollen on the anterior portions of the dorsum; pleurae dulled with gray pollen, more blackish than the dorsum. Abdomen green with very slight bronze reflections and narrow black incisures; the white pollen on its sides abundant. Hypopygium black; its lamellae moderately large, somewhat oval in outline, whitish with a narrow black border above and wider black border at apex, jagged and bristly on apical margin, fringed with black hairs above.

Fore coxae yellow with a small black spot at base on outer side, their anterior surface clothed with minute hairs, which are yellow on outer half and black on inner portion; middle and hind coxae black with yellow tips. Femora yellow; middle and hind femora each with one preapical bristle, the latter black at tip and ciliated below on their apical half, with scattering black hairs, the longest of which are nearly as long as the width of the femora, those near the tip very short; these hairs have a brownish or yellowish color in certain lights, and there are a few very delicate white hairs on the lower edge near the base. Fore and middle tibiae yellow, slightly darker toward their tips. Posterior tibiae black with the knees yellow, thickened, the glabrous stripe on upper surface between the rows of large bristles distinct. Fore tarsi one and a fourth times as long as their tibiae; first three joints yellowish with brown tips, first about one and a half times as long as second; fourth joint a little longer than the fifth, black, slightly compressed, fifth a little more compressed, oval, about twice as long as wide, still not conspicuously enlarged, black; pulvilli white. Middle tarsi a little longer than their tibiae, black from the tip of the first joint. Hind tarsi wholly black. Calypters and halteres yellow, the former with strong black cilia.

Wings grayish, strongly tinged with brown in front of third vein and narrowly so along the veins; costa with a small elongated enlargment at tip of first vein; last section of fourth vein moderately bent near its middle; tip of third and fourth veins rather far apart; hind margin of wing scarcely indented at tip of fifth vein; anal angle rather prominent.

Redescribed from the single type specimen in the United States National Museum, which was taken on Popoff Island, Alaska, July 11, 1899, by T. Kincaid.

Type.—Male, Cat. No. 5235, U.S.N.M.

No. 82. DOLICHOPUS PACHYCNEMUS Loew.

Dolichopus pachycnemus LOEW, Neue Beitr., vol. 8, 1861, p. 13; Mon. N. Amer. Dipt., pt. 2, 1864, p. 35.—Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 9, pl. 1, fig. 12. -Melander and Brues, Biol. Bull., vol. 1, 1900, p. 148.

Male.—Length 5.5-5.75 mm.; of wing 4.5 mm. Face wide for a male, dark ochre yellow, dulled with pollen. Front usually blue or violet edged with green, sometimes mostly green, shining. Antennae (fig. 82) black: first joint sometimes a little vellowish below: third joint about as long as wide, somewhat oval in outline, rather rounded at apex. Orbital cilia wholly black.

Thorax dark shining green, with a rather broad bronze vitta in the center of the dorsum; pleurae dulled with gravish pollen. Abdomen dark shining green with black incisures and spots of white pollen on the sides of the segments. Hypopygium black; its lamellae (fig. 82a) rather large, somewhat orbicular in outline, still with the outer corner nearly a right angle, whitish with wide black border at apex and narrow border above and on apical half of lower edge. jagged and bristly on apical margin, fringed above with rather long black hair.

Coxae black with their tips narrowly yellow; anterior pair covered with black hairs on the front surface. Femora and tibiae vellow. Middle and hind femora each with one preapical bristle, the latter with rather long hair above near the base and long black cilia on apical half of lower inner edge, the longest hairs being fully as long as the width of the femora. All tibiae with rather numerous and strong bristles; posterior pair (fig. 82b) with their apical half or more black, much thickened, and with a groove on upper surface which reaches from the tip to basal two-fifths, it is forked near the middle of the tibiae and yellowish in color. Fore tarsi (fig. 82c) a little longer than their tibiae, first three joints yellow, usually with their tips brown, third a little compressed and widened at apex; fourth and fifth joints black, compressed and fringed above with little black hairs, fourth about as wide at apex as it is long, fifth nearly round in outline, last three joints of nearly equal length. Middle tarsi scarcely as long as their

tibiae, black from the tip of the first joint, which has a large bristle near apical third above, and several bristles on the side. Hind tarsi wholly black. Calypters and halteres yellow, the former with long black cilia.

Wings uniformly tinged with dark gray; costs not enlarged at tip of first vein; last section of fourth vein a little bent just before its middle; hind margin of wing only a little indented at tip of fifth vein; anal angle of wing rather prominent but rounded.

Female.—Face wide, grayish white; fore tarsi plain, blackish from the tip of the first joint; hind femora without cilia; hind tibiae of normal size, with apical fifth or a little more black, this black not sharply defined; middle tibiae with a pair of bristles at apical third and two others preceding them on the lower surface.

Redescribed from 12 males and 4 females; J. M. Aldrich took 1 male at Erwin, South Dakota, June, 1908, and 3 pairs at Brookings, South Dakota, June 12, 1891. I took 8 males at Chatham, Ontario, June 17, 1915, and 1 male at East Aurora, New York, June 2, 1918.

Type localities.—Middle States; Illinois. Aldrich reports it from South Dakota, and Melander and Brues from Massachusetts. I have seen a female from Outremont, Quebec, June 20.

Type.—Museum of Comparative Zoology, Cambridge, Massachusetts.

No. 83. DOLICHOPUS UNGULATUS Linnaeus.

Musca ungulata Linnaeus, Fauna Suecica, ed. 2, 1761, No. 1858.

Nemotelus aeneus De Geer, Mem. Hist. Nat. Ins., ed. Goetze, 1782, p. 78.

Dolichopus aeneus Van der Wulf, Tidsch. v. Ent., vol. 22, 1869, p. 80.

Dolichopus ungulatus Lundbeck, Dipt. Danica, vol. 4, 1912, p. 146.

Male.—Length 6 mm.; of wing 5 mm. Face rather narrow, grayish, scarcely silvery. Front shining green. Antennae wholly black; third joint about as long as wide, somewhat pointed at tip: Orbital cilia wholly black.

Thorax green with a little white pollen on the anterior part of the dorsum; pleurae dulled with white pollen; scutellum with a fringe of little pale hairs on the lower edge of the hind margin. Abdomen green with coppery reflections toward the tip and narrow black incisures, and with conspicuous spots of white pollen on the sides of the segments. Hypopygium black, rather long; its lamellae (fig. 83a) large, somewhat oval in outline but nearly straight below, whitish with broad black border on apical margin and narrowly black along the upper edge, jagged and bristled at lower apical corner, otherwise fringed with delicate little brown hairs.

Fore coxae black at base, apical half or more yellow, their anterior surface covered with conspicuous black hairs; middle and hind coxae black with extreme tips yellow. Femora and tibiae yellow. All femora with long black cilia on apical half below, the longest hairs

on fore femora as long as the width of the femora, those on middle and hind pairs longer than their width. Middle and hind femora each with a longitudinal row of from three to five long bristles near the tip, the latter also with a row of long hairs above near the base. Tibiae with long stout bristles; posterior pair black at tip for nearly one-fourth their length; they have a glabrous stripe on inner surface of basal half. Fore and middle tarsi a little longer than their tibiae, the former yellowish becoming brown toward their tips, the latter black from the tip of the first joint. Hind tarsi wholly black. Calypters and halteres yellow, the former with long black cilia.

Wings (fig. 83) grayish; costa with an elongated enlargement at tip of first vein; last section of fourth vein bent at its middle; hind margin of wing indented at tip of fifth vein, and with just a suggestion of a lobe at tip of sixth vein caused by the anal angle narrowing toward the root of the wing.

Female.—Face broad, its pollen more silvery white, the cilia on the lower edge of the femora represented by short black hairs; middle tibiae with one or two bristles below and a row of five on the lower front edge; hind margin of wing more evenly rounded, the anal angle not being cut off obliquely as in the male. Middle basitarsi with a large bristle above.

Redescribed from 2 males and 2 females from Europe (Aldrich). Van der Wulp reports it from Wisconsin.

No. 84. DOLICHOPUS BARBIPES, new species.

Male.—Length 4-4.3 mm.; of wing 3.5 mm. Face rather wide, long, silvery white. Palpi unusually long, white, reaching beyond the brown proboscis, Front shining green. Antennae wholly black; first joint long, not widened at tip; as long as second and third taken together; third joint longer than wide, somewhat oval in outline. Orbital cilia wholly black. Proboscis black, palpi large, oval, snow-white.

Thorax shining green with bronze reflections, which color sometimes forms two lines, one each side of the acrostichal bristles, and with a very little white pollen on the front dorsum; pleurae usually with blue reflection, a little dulled with gray pollen. Abdomen green with coppery reflections, the apical segments mostly coppery; there are usually some blue reflections on the sides near the base. Hypopygium black; its lamellae large, somewhat oval, whitish, with a narrow black border on apical margin, which is jagged and bristly, fringed with delicate hairs on upper and lower edges.

Fore coxae wholly yellow, their anterior surface covered with silvery pollen, bare, except for the usual bristles at tip. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter nearly bare below. Anterior tibiae (fig. 84) fringed for their entire length on upper edge with very long black hairs which are as long as the basitarsi; outside of these hairs is a bare stripe the whole length of the tibiae; below at basal third there is a delicate black bristle. Middle tibiae with a row of about nine bristles on the lower edge of the apical half; posterior pair narrowly black at tip, not thickened. Fore and middle tarsi yellowish brown at base, becoming black from the tip of the first joint, one and a fourth times as long as their tibiae, the former with fourth and fifth joints of equal length. Hind tarsi wholly black, their basitarsi with one large bristle above. Calypters and halteres yellow, the former with pale cilia.

Wings grayish, slightly tinged with brown in front and along the cross vein; costa scarcely enlarged at tip of first vein; last section of fourth vein considerably bent at middle; hind margin of wing a little indented at tip of fifth vein; anal angle rounded so as to make the wing narrow at base.

Female.—Face nearly as wide as the front, silvery white; antennae only a little shorter than those of the male; fore coxae with little black hairs on their anterior surface; tibiae with their bristles and hairs normal, middle pair with two or three bristles below, their basitarsi without a bristle above; hind basitarsi with one bristle above; the cilia of the calypters appear black in some lights and yellowish or whitish in others. I do not see this change of color in any of the males before me. These cilia are rather short and not very abundant in either sex.

Described from 7 males and 3 females taken by J. M. Aldrich, at Wells, Nevada, July 12, 1911.

The name for this species was proposed by Prof. J. M. Aldrich and is very appropriate, the long hairs on the fore tibiae and the bristles on the lower surface on middle tibiae being quite remarkable.

Type.—Male, Cat. No. 23018, U.S.N.M.

No. 85. DOLICHOPUS BREVIPENNIS Meigen.

Dolichopus brevipennis Meigen, Syst. Beschr., vol. 4, 1824, p. 89.—Loew, Mon. N. Amer. Dipt., pt. 2, 1864, p. 37.—Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 10, pl. 1, fig. 6.—Lundbeck, Diptera Danica, pt. 4, 1916, p. 144, fig. 45.

Male.—Length 5.5 mm.; of wing 4.5 mm. Face rather wide, ocher yellow, paler below. Front dark shining green. Antennae black; third joint slightly longer than wide, somewhat oval in outline, only a little pointed at tip. Orbital cilia wholly black.

Thorax dark green, with a more or less distinct median bronze vitta on the dorsum; pleurae a little dulled with gray pollen. Abdomen dark green with bronze reflections, which are more distinct on

the hind margins of the segments. Hypopygium black; its lamellae rather large, somewhat oval in outline, yellowish with rather broad black border, jagged and bristly at apex; these bristles extend well toward the base on upper edge.

Fore coxae yellow with a black or greenish spot at base on outer side, anterior surface with black hairs. Middle and hind coxae black with their extreme tips yellow. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter ciliated below with long yellow hairs, the longest of which are nearly twice as long as the width of the femora. Posterior tibiae only a little thickened and with apical third black. Fore tarsi (fig. 85a) about one and a half times as long as their tibiae; the first three joints slender, yellow, fourth black, a little compressed, widened at tip, being nearly as wide at tip as it is long, fifth black, much compressed and widened, oval, about as long as third and two-thirds as wide as long. Middle tarsi a little longer than their tibiae, black from the tip of the first joint, the first joint sometimes blackened almost to the base. Hind tarsi wholly black. Calvpters and halteres yellow; the former with black cilia.

Wings (fig. 85) dark grayish; costa with an elongated enlargement at tip of first vein, which is as long as the cross vein; last section of fourth vein bent just before its middle; hind margin of wing scarcely indented at tip of fifth vein; anal angle rather prominent.

Female.—Face wide, gray; third antennal joint scarcely as long as wide; fore tarsi plain, a little longer than their tibiae, infuscated from the tip of the first joint, which is a little shorter than the remaining four taken together, third a very little shorter than the second, fifth longer than the fourth; hind femora without cilia below; hind tibiae blackened at tip for one-fourth their length; middle basitarsi with a large bristle above; costa without an enlargement at tip of fifth vein, still it is a little thickened at that point, tapering to its tip.

Redescribed from 3 males from Sweden (Aldrich). Mr. Kennicott took specimens at Fort Resolution, Hudson Bay Territory, which Doctor Loew compared with European specimens and considered the determination correct. The description of the female is from this material, the males seem to have been destroyed.

No. 86. DOLICHOPUS DASYOPS Malloch.

Dolichopus dasyops Malloch, Report Canadian Arctic Expedition, vol. 3, pt. C, 1919, p. 49.

The following is the original description by Mr. Malloch:

Male.—Blue-black, with a distinct cupreous tinge. Antennae and arista black; face black, with dense yellowish brown pile; palpi yellow; proboscis black; postocular cilia entirely black; hairs on eyes yellow. Dorsum of thorax with coppery tinge; fringes of squamae black. Hypopygium black, lamellae white, blackened on apical

margins and with black hairs. Legs yellow, fore coxae slightly infuscated at bases, mid and hind pairs black; apices of hind tibiae, apices of basal three, and all of apicaltwo, joints of fore tarsi, all but base of mid tarsi, and entire hind tarsi fuscous. Wings clear, veins dark brown. Halteres yellow.

Eyes hairy; antennae not elongated, third joint pointed, shorter than high (pl. 8, fig. 8); arista with second joint much elongated, third densely pubescent; face parallelsided, about one-sixth the head-width at its middle, not descending to lowest level of eyes. Scutellum with two strong bristles and two weak hairs. Hypopygial lamella (fig. 86) as in pl. vii, fig. 9. Fore coxae with short black hairs, and a few bristles near apex; fore tibia with three to four antero-dorsal, two postero-dorsal, and three to four posterior bristles; fourth joint of fore tarsi dilated from base to apex, fifth very much broadened, its width about equal to its length; mid tibia with one ventral, two to three antero-ventral, four to five antero-dorsal, and five to six posterior bristles; mid tarsi simple, with a few short bristles on apical half of basal joint, one of which on dorsal surface is conspicuous; hind femora with inconspicuous black hairs on apical portion of postero-ventral surface; hind tibiae with short regular hairs on basal two-thirds of antero-ventral surface and one long bristle beyond these, antero-and posero-dorsal surfaces each with about eight long bristles; postero-dorsal surface with a slit at apex which runs forward on to dorsum; posterior surface densely black setulose on apical half; basal joint of hind tarsi with about eight bristles in two irregular series. Curve of fourth vein distinct but not abrupt; apices of third and fourth veins subparallel; costa not noticeably swollen at apex of first vein.

Length, 5.25 mm.

Type locality: Bernard Harbour, Dolphin and Union Strait, Northwest Territories, July 10, 1916 (F. Johansen).

This species is most closely allied to brevipennis Meigen, but differs in having the hind femora without long pale hairs on ventral surface.

This is a copy of the original description by J. R. Malloch. I have not seen the species.

Type.—In the Canadian National Collection, Ottawa.

No. 87. DOLICHOPUS ORNATIPENNIS, new species.

Male.—Length, 4.5 mm.; of wing the same. Face wide, yellowish gray. Front blue-green, shining. Antennae black; lower edge of first joint narrowly yellowish; third joint about as long as wide, conical in outline, still a little rounded at tip. Orbital cilia wholly black.

Thorax green with coppery reflections; front of the dorsum dulled with gray pollen, pleurae with white pollen. Abdomen green with coppery reflections; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black; its lamellae (fig. 87a) of moderate size, somewhat oval, a little longer than wide, pale brownish with a narrow black border on upper, apical, and lower edges, jagged and bristly on apical margin, fringed with black hairs above.

Fore coxae yellow with a conspicuous black spot at base on outer side, their anterior surface covered with black hairs. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter without cilia below, the little black hairs on their sides descending to the lower

edge. Posterior tibiae slightly thickened, narrowly black at tip, and with a brown spot on inner side at basal third. Fore tarsi plain, a little longer than their tibiae, black from the tip of the first joint, which is brownish yellow and as long as the three succeeding joints taken together; fourth and fifth of nearly equal length. Middle tarsi a little longer than their tibiae, black from the tip of the first joint, which has a large bristle above. Hind tarsi wholly black. Middle tibiae with a pair of bristles below at apical third and one at basal Calvoters and halteres vellow, the former with black cilia.

Wings (fig. 87) dark grayish, with a large, brown spot, reaching from opposite the cross-vein to the tip of the third vein and from the costa to just back of the third vein, the other veins also bordered with brown; costs with a small enlargement at tip of first vein; last section of fourth vein a little bent before its middle: third vein bent backward at tip, but nearly parallel with fourth; hind margin of wing indented at tip of fifth vein; anal angle rather prominent but rounded.

Described from 2 males from Massachusetts, 1 taken at Sharon, August 9; 1 at Bridgewater, July 11.

Type.—In the Boston Museum of Natural History.

No. 88. DOLICHOPUS DORYCERUS Loew.

Dolichopus dorycerus LOEW, Centuries, vol. 1, 1864, p. 85; Mon. N. Amer. Dipt., pt. 2, 1864, p. 326.

Male.—Length 5.5 mm.; of wing 6.2 mm. Face wide (Loew says that it is more "ochre-brown than ochre-yellow;" my specimen is greasy). Front violet, edged with green. Antennae (fig. 88a) with the first joint and more or less of the second yellow, short but normal; third black, second and third taken together somewhat orbicular in outline; arista black, slender, tapering, tipped with a somewhat elliptical, almost fusiform lamella. Orbital cilia wholly black.

Thorax and abdomen green with coppery reflections. Hypopygium black; its lamellae of moderate size, somewhat oval in outline, longer than wide, white with a black border, which is wide on apical, narrow on upper margin, jagged and bristly at apex, fringed above with black hairs, below with a few pale ones.

Fore coxae yellow with a blackish spot at base on outer surface, the anterior side with rather conspicuous black hairs; mixed with these are a few minute yellow ones. Middle and hind coxae black, the former with extreme tips and trochanters yellow, posterior trochanters blackish. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle (Loew states there are usually two preapical bristles on hind femora), the latter not ciliated below. Posterior tibiae scarcely thickened; on their inner surface near basal

third is an elongated, brown, slightly swollen spot; extreme tip slightly blackened on inner surface; in my specimen one of the hind tibiae has an additional brownish band near apical third. Fore tarsi (fig. 88b) about one and a fourth times as long as their tibiae; first joint yellow with its extreme upper edge and tip black; slightly enlarged at tip, as long as the remaining four joints taken together; last four joints deep black, of nearly equal length, compressed; second joint about as long as wide at apex; third and fourth joints expanded on upper edge into thin lobes which are nearly as wide as the length of the joints and twice as long, fifth joint also expanded into a lobe, but this lobe is whitish except at its base and half as long as the joint; pulvilli small, white. Middle and hind tarsi longer than their tibiae, black from the tip of the first joint; middle basitarsi with a bristle above at apical fourth. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 88) grayish, slightly tinged with yellowish brown on costal edge; costa slightly enlarged at tip of first vein, tapering to their tips; third vein running rather close to the second to a point opposite the tip of second where it bends backward in a curve, so as to approach the costa at an acute angle and running nearly parallel with it for a short distance; last section of fourth vein a little bent at its middle, the outer portion a little arcuate; hind margin of wing scarcely indented at tip of fifth vein, but with a deep sinus before the tip of sixth vein and another beyond it so as to leave a large lobe at tip of sixth vein and the anal angle rounded.

Female.—Face wide, grayish white; third antennal joint nearly orbicular, scarcely pointed, slightly longer than in the male; middle tibiae with two pair of bristles below; fore tarsi a little longer than their tibiae, black from the tip of the first joint, which is as long as the three succeeding joints taken together, fourth and fifth of nearly equal length; third vein separated from second as usual, only a little bent backward at tip; anal angle of wing prominent, beyond this the hind margin is sinuated just enough to suggest the lobe so prominent in the male.

Redescribed from 1 male taken at Bretton Woods, New Hampshire, June 30 and 1 female labeled White Mountains, New Hampshire.

Type locality.—White Mountains, New Hampshire, July 2. In 1908 I took a male at Lancaster, New York, which I sent to C. W. Johnson; he determined it as this species, but we could not find the specimen in his collection when I was there on January 17, 1919. No doubt he was correct in the determination; it is the only time it has been reported, except from the White Mountains, New Hampshire.

No. 89. DOLICHOPUS SOCIUS Loew.

Dolichopus socius LOEW, Cent., vol. 2, 1862, p. 60; Mon. N. Amer. Dipt., pt. 2, 1864, p. 40.—Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 10.

Male.—Length, 4.2 mm.; of wing, the same. Face rather wide, silvery white, tinged with yellow on upper part. Front shining green. Antennae black; first joint broadly yellow below; third large, somewhat oval in outline, but pointed at tip, nearly twice as long as wide. Lateral and inferior orbital cilia whitish, only a few of the upper cilia black.

Thorax green with bronze reflections, which usually form more or less distinct vittae on the front of the dorsum, where there is also a little white pollen; pleurae dulled with white pollen. Abdomen green with black incisures and bronze reflections; the white pollen on the sides quite distinct. Hypopygium black; its lamellae rather small, somewhat oval in outline, whitish, bordered with black on apical margin, and more narrowly on upper edge, jagged and bristly at apex, fringed with black hairs above.

Fore coxae pale yellow, with silvery pollen and very minute pale hairs on anterior surface. Middle and hind coxae black with yellow Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter with a row of very delicate vellow hairs on lower inner edge, these hairs are nearly one-fifth as long as the width of the femora, still scarcely long enough to call cilia, the black hairs on upper edge become long at base, the longest being about three-fourths as long as width of femora. Posterior tibiae slightly thickened, their tips black for about one-sixth their length; the glabrous stripe on upper surface quite distinct, although broken up by the irregular placing of the large bristles and a few black hairs, it extends upon the inner side of the tibiae at basal third. Fore tarsi about one and a half times as long as their tibiae, yellow, tip of first joint and the whole of second, third, and fourth joints, except their extreme bases, black, fifth dark vellow; the joints of decreasing length, first about as long as the two following taken together. dle tarsi a little longer than their tibiae, black from the tip of the first joint, still the apical half of fifth a little vellowish, usually quite distinctly so. Hind tarsi wholly black. Calvpters, their cilia, and the halteres pale vellow.

Wings (fig. 89) gravish; costa without enlargement at tip of fifth vein; last section of fourth vein a very little bent just before its middle; third vein bent backward at tip; hind margin of wing a little indented at tip of fifth vein; anal angle nearly obsolete, the wing being narrowed at base.

Female.—Face wide, silvery white; third antennal joint smaller than in the male; fore coxae with minute black hairs on anterior surface; anal angle of wing a little more developed than in the male; cilia of calypters sometimes black, although they seem to be yellow in most specimens. The fifth joint of fore tarsi more or less yellow, usually colored as in the male.

Redescribed from the type material and specimens from the following locations: Bennington, Vermont, June 24; Eastport, Maine, July 14; Southwest Harbor, Maine, July 10; Cohasset, Massachusetts, June 10; Big Stone City, South Dakota; Toronto, Ontario, May 23; Montreal, Quebec, June 7; Hood River, Oregon, June 3 and 4, 1917. (Cole).

Type locality.—Illinois.

Type.—In Museum of Comparative Zoology, Cambridge, Massachusetts.

No. 90. DOLICHOPUS SOCIUS Loew, var. GLADIUS, new variety.

Male.—Length 3.5-4.5 mm.; of wing the same. Face of moderate width, narrowed below, silvery white. Front shining green. Antennae black; first joint yellow below; third joint oval, usually with an obtuse point at tip, but sometimes rounded. Lateral and inferior orbital cilia yellowish white, a few of the upper cilia black.

Thorax shining green with more or less coppery reflections on the dorsum, which often form two distinct narrow vittae, leaving a green stripe between them; pleurae dulled with gray pollen. Abdomen green with coppery reflections and narrow black incisures, and with spots of white pollen on the sides of the segments. Hypopygium black, its lamellae of moderate size, somewhat oval in outline, nearly one and a half times as long as wide, white with narrow black border, jagged and bristly on apical margin, otherwise fringed with delicate black hairs.

Fore coxae wholly or almost wholly yellow, anterior surface with silvery pollen and minute pale hairs; middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter with a row of delicate little yellow hairs on lower inner edge and with the black hairs on upper edge becoming longer at base, posterior tibiae with their tips black for about one-sixth their length. Fore tarsi slightly longer than their tibiae, black from the tip of the first joint, which is about as long as the two following taken together, second a little longer than third, fourth and fifth of about equal length, each shorter than the third. Middle tarsi about one and a fourth times as long as their tibiae, black from the tip of the first joint. Hind tarsi wholly black. Calypters, their cilia, and the halteres yellow.

Wings (fig. 90) grayish, often distinctly tinged with brown in front of the third vein; costa with a very slight knotlike enlargement at tip of first vein; last section of fourth vein a little bent before its middle; hind margin of wing scarcely indented at tip of fifth vein;

anal angle nearly obsolete, the wing being narrowed toward its base.

Female.—Face broad; costa without enlargement at tip of first vein; anal angle of wing a little more developed; middle tibiae with one bristle below, their basitarsi without a bristle above. Cilia of the calypteres yellow; there are specimens which seem to belong to this variety that have these cilia black, but they may be the females of some other species. The fifth joint of fore tarsi black, not paler than those preceding it.

Described from numerous specimens from the following localities: New Hampshire; western New York, June 29 to August 4; Ontario, May 16-July 28; Quebec, July; Summerside, Prince Edward Island, Canada, July 21 (E. M. Walker).

Type.—Male, Cat. No. 23019, U.S.N.M., from Toronto.

This variety is of uncertain value. Some may not think it should have a distinctive name, others might even consider it a distinct species.

The two species socius and brevimanus have long been confused. Prof. J. M. Aldrich considered them synonymous after examining the types, but although I could find no difference of value when I looked over the type material in January, 1919, still it is my opinion that they are distinct species and that the specimens standing under brevimanus in the Loew collection are not the ones he described the species from; they do not quite answer his description, which gives the difference between the two forms very clearly. I find both forms in the material now in my hands. The most noticeable difference between them is that in brevimanus the black hairs on the sides of the hind femora descend to its lower edge, so that when viewed from below they show two rows of little black hairs with a glabrous space between them; while in socius there is a row of delicate little yellow hairs on the lower inner edge, which although sometimes easily overlooked can always be seen.

In going over the material having these yellow hairs on lower inner edge we find two forms which have quite a different appearance, still when we come to look for distinguishing characters they are not so easily separated as one would think. One series has the fifth joint of the fore tarsi yellow (in fact, the fifth joint of all the tarsi is more or less yellowish, at least at tip), the other series have the fifth joint of fore tarsi black, not paler than those preceding it. I found that the type specimens had the fifth joint yellow, so the first series is the typical form of socius Loew.

In the series before me, those with the yellow fifth joint also have the face a trifle more yellow on upper part; third antennal joint distinctly larger and longer, the first joint also seems to be more broadly yellow below; the row of yellow hairs on the lower inner edge of the hind femora a little longer; there is no trace of the small knotlike enlargement of the costa; the third vein is bent backward a little more at tip; the bend in the last section of fourth vein is less and beyond this bend the fourth vein is a little arched; the wing is a very little wider on its basal half; the lamellae of the hypopygium are also a very little smaller.

All these differences are rather small, but I can scarcely pass them by without separating the two forms, therefore I propose the name of *gladius* for the form with black fifth tarsal joints because of its shorter third antennal joint, the name meaning a short sword.

This is the form I have taken around Buffalo, New York; the typical form seems the most abundant in the New England States and also seems more widely distributed, being found in the Eastern States, Canada, North Dakota, and Oregon, while I have only seen this form from the Eastern States, eastern Canada, and western New York, but no doubt it will be found farther west.

No. 91. DOLICHOPUS BREVIMANUS Loew.

Dolichopus brevimanus Loew, Neue Beitr., vol. 8, 1861, p. 14; Mon. N. Amer. Dipt., pt. 2, 1864, p. 39.—Melander and Brues, Biol. Bull., vol. 1, p. 148.

Male.—Length 4 mm.; of wing 3.75 mm. Face rather wide, a little narrowed below, silvery white. Front shining green. Antennae black; first joint yellow below; third rather large; somewhat oval in outline, but pointed at tip. Lateral and inferior orbital cilia whitish, a few of the upper cilia black.

Thorax green, its dorsum shining, with a little white pollen along the front; pleurae dulled with white pollen. Abdomen green with narrow black incisures and with spots of white pollen on the sides of the segments. Hypopygium black, its lamellae rather large, oval in outline, whitish with narrow black border, jagged and bristly at apex, fringed above with black hairs.

Fore coxae yellow with silvery pollen and very minute pale hairs on their anterior surface and a few black ones at inner upper corner, femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter with the black hair on upper edge becoming long at base and with the little black hairs on their sides reaching the lower edge on both inner and outer sides, so when they are viewed from below there are two rows of little black hairs with a glabrous stripe between them on the lower surface of the femora. Posterior tibiae with their tips black for one-sixth their length. Fore tarsi a little longer than their tibiae, yellow, a little infuscated at tip, first joint about as long as second and third taken together, third to fifth each a little shorter than the joint preceding it; middle tarsi about one and a fourth times as long as their tibiae, black from the tip of

the first joint, hind tarsi wholly black. Calypters, their cilia, and the halteres yellow.

Wings (fig. 91) a little grayish; costa not thickened at tip of first vein; last section of fourth vein a little bent before its middle; hind margin of wing scarcely indented at tip of fifth vein; anal angle nearly obsolete, the wings being narrowed toward their base, still the anal angle is a little prominent.

Female.—Face wide; third antennal joint about as long as broad; fore coxae with minute black hairs on the front surface; fore tarsi one-fourth longer than their tibiae; hind femora without the rows of black hairs below; wings brownish along the front with the anal angle more developed.

Redescribed from one pair from New Hampshire and several males from Ithaca, New York.

Type locality.—District of Columbia.

Type.—Museum of Comparative Zoology, Cambridge, Massachusetts.

No. 92. DOLICHOPUS INDIGENA, new species.

Male.—Length 4.5 mm.; of wing 4 mm. Face rather wide, a little narrowed below, silvery white. Front shining green. Antennae black; first joint yellow on lower half or less; third joint a little longer than wide (in one specimen it is not any longer), scarcely pointed at tip, which is somewhat rounded. Lateral and inferior orbital cilia pale, a few of the upper cilia black.

Thorax green; dorsum shining, with coppery reflections at the suture; pleurae dulled with white pollen. Abdomen green with coppery reflections; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black; its lamellae moderately large, somewhat oval in outline, jagged and bristly at apex, fringed with yellow or brownish hairs on upper edge, white with very narrow black border on apical and upper edges.

Fore coxae wholly or almost wholly yellow, with very minute yellow hairs on the anterior surface; middle coxae black with yellowish tips; hind coxae yellow, with a large black spot on outer surface and a small one on posterior side. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the hind with a row of minute delicate yellow hairs on lower inner edge. Posterior tibiae black at tip for one-sixth their length. Fore tarsi (fig. 92a) slightly longer than their tibiae, black from the tip of the first joint; first joint a little longer than the second and third taken together, which are of equal length, fourth and fifth joints also of equal length, and each a very little shorter than the third; last four joints each distinctly narrowed at base. Middle tarsi one and a fourth times as long as their tibiae, black from the tip of the first joint, which is a little shorter than the three following joints taken together and

without a bristle above, fourth and fifth of nearly equal length. Hind tarsi wholly black. Calypters, their cilia, and the halteres yellow.

Wings (fig. 92) grayish; costa with a slight knot-like enlargement at tip of first vein; last section of fourth vein a little bent before its middle; hind margin of wing a little indented at tip of fifth vein; anal angle rounded, not very prominent.

Female.—Face wide, silvery white; fore tarsi with the second joint only a little longer than the third, last three joints of nearly equal length; costa without an enlargement; middle tibiae with one bristle below; fore and hind coxae as in the male.

Described from 18 males and 2 females. I have taken it at Buffalo, New York, June 24; South Wales, Eric County, New York, July 9; Toronto, Ontario, July 3 and 4. H. S. Parish took it at Coniston, Ontario, July 27. A. L. Melander took it at Mica, Washington, July 14; Lake McDonald, Glacier Park, Montana, August 14, and Priest Lake, Idaho, August 1.

Type.—Male, Cat. No. 23020, U.S.N.M., from Priest Lake, Idaho.

No. 93. DOLICHOPUS IDONEUS, new species.

Male.—Length 4-4.5 mm.; of wing 3.75-4 mm. Face rather narrow, silvery white. Front shining green. Antennae black; first joint conspicuously yellow below; third rather large, longer than wide, somewhat oval in outline, pointed at tip. Lateral and inferior orbital cilia whitish, a few of the upper cilia black.

Thorax green with a very little white pollen along the front of the dorsum, and a distinct bronze vitta between the acrostichal bristles; pleurae dulled with white pollen. Abdomen green with slight coppery reflections and black incisures; the spots of white pollen along its sides large. Hypopygium black; its lamellae (fig. 93a) small, somewhat oval in outline, about one and a fourth times as long as wide; white, rather broadly black at apex, narrowly along the upper edge, which has about seven bristle-like hairs placed at regular and rather wide intervals.

Fore coxae yellow, with a few minute black hairs on inner edge of anterior surface near base, which is otherwise covered with very delicate, minute, yellow hairs, so small as to make the front surface appear nearly bare. Middle and hind coxae black, with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter without cilia below, but with the little black hairs on their sides descending to the lower edge, the lower rows on each side a little longer than those on the sides and leaving a broad glabrous stripe between them. Posterior tibiae with their tips black for one-fifth their length, a glabrous line just inside of the inner row of large bristles. Fore and middle tarsi about one and a fourth times as long as their tibiae; the former yellow, scarcely infuscated at tip,

their joints of regularly decreasing length; middle tarsi black from the tip of the first joint. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia, still appearing yellow in certain lights.

Wings (fig. 93) grayish; costa not distinctly enlarged at tip of first vein, tapering to its tip; last section of fourth vein a little hent before its middle; hind margin of wing indented at tip of fifth vein; anal angle not prominent.

Described from 2 males; 1 taken by me at East Aurora, New York June 9, 1918; the other at Lynden, Vermont, June 13, 1914, by A. L. Melander.

Type.—Male, Cat. No. 23021, U.S.N.M., from East Aurora, New York. This differs from canadensis in having the lamellae smaller and more regularly oval, the fore tarsi almost wholly yellow, and with the fifth joint shorter than the fourth; while in canadensis the fifth joint is a little longer than the fourth and the last two and a half joints are black.

No. 94. DOLICHOPUS CANADENSIS, new species.

Male.—Length, 4.75 mm.; of wing, 3.75 mm. Face moderately wide, silvery white. Front shining green with bronze reflections in the center. Antennae (fig. 94) black, first joint yellow below; third joint one and a half times as long as wide, oval, still obtusely pointed at tip. Palpi yellow. Lateral and inferior orbital cilia white, about seven of the upper cilia on each side black.

Thorax shining green with a little white pollen on the anterior portion of the dorsum, which has a rather broad, median, shining vitta; this vitta and a spot on each side at the transverse suture are more or less bronze colored; pleurae dulled with white pollen. Abdomen shining green with slight bronze reflections, which are more conspicuous on the apical segments, and white pollen on the lower part of its sides. Hypopygium black; its lamellae large, nearly twice as long as wide, rounded at apex, gradually tapering into the stem; white with a black border on the apical margin, the lower corner of which is jagged and bristly, fringed above with delicate brown hairs.

Fore coxae wholly yellow with silvery pollen and minute yellow hairs on the anterior surface, a few minute black hairs on their inner edge. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter nearly glabrous below on inner side. Posterior tibiae scarcely thicker than the others, a little infuscated at tip, especially on inner surface, where they are quite black for a short distance. All tarsi about one and a fourth times as long as their tibiae; anterior pair (fig. 94a) yellow, blackened from the middle of the third joint. fifth almost imperceptibly compressed, longer than fourth joint,

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about equal to third in length; middle tarsi black from the tip of the first joint; hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia, usually with a few of the upper ones yellowish.

Wings grayish; costa scarcely thickened at tip of first vein; last section of fourth vein a little bent before its middle; hind margin of wing scarcely indented at tip of fifth vein, rather evenly rounded, but the wing quite narrow; anal angle not developed.

Female.—Face wide, white; fore tarsi yellowish, black from the middle of the third joint, but the black not distinctly defined; last three joints of nearly equal length; wings tinged with brown in front, more broadly rounded than in the male, anal angle more developed. In both male and female the middle tibiae have three bristles below, one at basal, two at apical third, their basitarsi usually with a rather small bristle above at apical third.

Described from 7 males and 2 females. T. M. Willing took 1 at Regina, July 1; I took 5 at Kearney, Ontario, July 2-8; J. M. Aldrich took 2 at Erwin, South Dakota, in June, 1908, and 1 on Turtle Mountains, near Bottineau, North Dakota, June 21, 1918.

Type and allotype in the United States National Museum, taken at Kearney, Ontario.

Type.—Male, Cat. No. 23022, U.S.N.M.

No. 95. DOLICHOPUS ACUTUS, new species.

Male.—Length 4.25 mm.; of wing 3.5 mm. Face moderately wide, silvery white. Front green with bronze reflections. Antennae (fig. 95a) with the first joint yellow, a little darker on upper edge when viewed from the inner side, but the outer side has the upper edge deep black; this black nearly reaches across the apical end of the joint and is sharply defined; third joint nearly three times as long as wide, tapering into a rather acute point; arista subapical, inserted just above the point. Palpi pale yellow with yellowish hairs. Lateral and inferior orbital cilia white, about six of the upper cilia on each side black.

Thorax shining green with coppery reflections; pleurae dulled with white pollen. Abdomen shining green with coppery reflections, the apical segments mostly coppery; the white pollen on its sides rather abundant. Hypopygium black, its lamellae large, nearly as long as the hypopygium, elliptical, yellowish at base, becoming white. They have a broad black border on apical margin, where they are a little jagged and bristly, otherwise they are fringed with delicate brown hairs.

Fore coxae wholly yellow, their anterior surface covered with silvery pollen and minute white hairs. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind

femora each with one preapical bristle; the former also has a smaller bristle on the posterior side close to the tip; hind femora nearly glabrous below. Posterior tibiae only slightly thicker than the others, their tips black for one-fifth their length, this black being poorly defined. All tarsi one and a fourth times as long as their tibiae; fore tarsi yellow with the last two joints black, still the base of the fourth is yellowish; first joint as long as the three following joints taken together; middle tarsi black from the tip of the first joint; hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia, which however have a yellowish color when viewed in certain directions.

Wings (fig. 95) grayish; costa not enlarged at tip of fifth vein; last section of fourth vein a little bent before its middle; hind margin of wing scarcely indented at tip of fourth vein, rather evenly rounded, the anal angle being only moderately developed.

Described from 1 male taken at Springfield, Massachusetts, by G. Dimmock.

Type.—Male, Cat. No. 23023, U.S.N.M.

No. 96. DOLICHOPUS DEFECTUS, new species.

Male.—Length, 4 mm.; of wing, 3.5 mm. Face rather wide for a male, silvery white. Front dark shining green. Antennae (fig. 96a) black; first joint yellowish below, still sometimes the first joint is almost wholly black; third joint rather large, a little longer than wide, somewhat oval in outline, scarcely pointed at tip. Lateral and inferior orbital cilia pale, a few of the upper cilia black.

Thorax dark green or blue-green, shining; pleurae dulled with white pollen. Abdomen green, sometime with coppery reflections, its incisures black; the white pollen on its sides not very conspicuous. Hypopygium black; its lamellae moderately large, somewhat oval or more quadrilateral in outline, being rather truncate at tip and abruptly narrowed into the stem, white with narrow black border on apical and upper margins, jagged and bristly on outer end, fringed with blackish hairs above.

Fore coxae yellow with a small blackish spot on outer surface near the base, their anterior surface nearly bare, still with a few minute black hairs, especially along the inner side. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter nearly bare below, but with a row of very delicate short hairs on lower inner edge; posterior tibiae black at tip for about one-fifth their length, the glabrous stripe on upper surface can be seen as a shining line between the rows of large bristles, inside of the inner row of bristles is another glabrous line extending nearly the whole length of the tibia. Fore and middle tarsi about one and a fourth

times as long as their tibiae, black from the tip of the first joint, anterior pair with the first joint as long or slightly longer than the two following taken together, second to fifth joints of regularly decreasing length. Hind tarsi wholly black. Calypters and halteres yellow, former with black cilia.

Wings (fig. 96) grayish; costa with a very small knotlike enlargement at tip of first vein; last section of fourth vein a little bent beyond its middle; hind margin of wing scarcely indented at tip of fifth vein; anal angle but little developed.

Female.—Probably the females with the cilia of the calypters black that I have placed with socius Loew are the females of this species, as some of them had yellowish cilia and others black.

Described from five males. One taken at East Aurora, New York, July 29; one at Niagara Falls, New York, July 20; one at Niagara Falls, Ontario, July 20; and two at Toronto, Ontario, July 4.

This form is almost like socius, var. gladius, differing from that in the color of the cilia of the calypters.

Type.—Male, Cat. No. 23024; U.S.N.M., from Toronto.

No. 97. DOLICHOPUS ABBREVIATUS, new species.

Male.—Length, 4 mm.; of wing the same. Face wide, silvery gray, scarcely narrowed below. Front shining green. Antennae black; first joint conspicuously yellow below; third joint moderately large, a little longer than wide, somewhat conical in outline, pointed at tip. Lateral and inferior orbital cilia yellowish, about five of the upper cilia on each side black.

Thorax green with coppery reflections, a little dulled with grayish pollen; pleurae with white pollen. Abdomen green with coppery reflections along the hind margins of the segments; the white pollen on its sides abundant. Hypopygium black; short but about as thick as usual; its lamellae (fig. 97) small, somewhat triangular in outline, but rounded at tip, yellowish with a rather narrow black border on the apical margin, which is a little jagged and bristly.

Fore coxae in the allotype wholly yellow, in the other specimen they are blackened at base on outer side, their anterior surface covered with silvery pollen and little yellow hairs; there are a few small black hairs on the inner edge. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter not ciliate below, but with the little black hairs descending to the lower edge of both outer and inner sides. Posterior tibiae scarcely thickened, narrowly black at tip; the glabrous stripe between the large bristles not conspicuous. Fore tarsi plain, a little longer than their tibiae, infuscated from the tip of the first joint, which is as long as the three following taken together; fifth joint very slightly longer than the fourth. Middle

tursi a little longer than their tibiae, black from the tip of the first joint, which is without a bristle on its upper surface. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia with which are mixed several pale hairs.

Wings gravish, tinged a little with yellowish in front of third vein; costa not enlarged at tip of first vein; last section of fourth vein only a little bent beyond basal third; third and fourth veins a little convergent; hind margin of wing a little indented at tip of fifth vein, rather evenly rounded, the anal angle not being very prominent.

Described from two males. One was taken by C. W. Johnson at Machias, Maine, July 21; the other was taken by L. M. Turner at Ungava Bay, Labrador, July 22, and is in the United States National Museum.

Type.—Male, Cat. No. 23025, U.S.N.M., from Labrador.

The hypopygium is remarkably short but as thick as usual; it is formed about as it is in ramifer and cuniculus; ramifer differs from both of the other species in having a stump of a vein at the bend in last section of fourth vein. It differs from cuniculus in having the first antennal joint yellow below, and the third and fourth veins convergent beyond the bend in fourth; in cuniculus the antennae are wholly black, with the third joint smaller, and the third and fourth weins are nearly parallel beyond the bend in fourth.

No. 98. DOLICHOPUS CUNICULUS, new species.

Male. Length 3.5 mm.; of wing the same. Face wide, silvery white. Front dark shining green with the white pollen of the face extending narrowly along the orbits. Antennae (fig. 98b) black with the lower apical corner of the first joint a little yellowish; third joint a little longer than wide, rounded at tip. Lower orbital cilia white.

Thorax green; dorsum with a median bronze vitta, on each side of which there is a shining green line, lateral portions of the dorsum with bronze reflections; pleurae dulled with a little white pollen. Abdomen green; the white pollen on its sides abundant and reaching upon the dorsum. Hypopygium (fig. 98) short and rather slender, reaching forward to about the middle of the fourth abdominal segment; its lamellae very small, somewhat triangular, yellowish, the apical margin scarcely darker and not jagged, lamellae fringed with delicate whitish hairs.

Fore coxae yellow with a blackish spot at base on outer surface, anterior surface covered with silvery pollen and little black hairs. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter without cilia below. Posterior tibiae scarcely stouter than the others, narrowly black at tip. Fore tarsi a little longer than their tibiae, black from the tip of the first joint, which is as long as the remaining four joints taken together, second joint scarcely longer than the third, fifth shorter than third but longer than fourth, last four joints very slightly compressed. Middle tarsi about one and a third times as long as their tibiae, black from the tip of the first joint, which has two bristles on upper edge, one at basal fourth and one at basal third. Calypters yellow with black cilia; halteres yellow with their stem brownish.

Wings (fig. 98a) grayish; costa rather thick beyond the tip of first vein but without an enlargement; last section of fourth vein with a small but rather abrupt bend near its middle; hind margin of wing scarcely indented at tip of fifth vein, rather evenly rounded, the anal angle being poorly developed.

Described from 1 male taken by me on Grand Island, New York, August 17, 1913.

Type.—Male, Cat. No. 23026, U.S.N.M.

This may prove to be the male of brunneus Aldrich, it differs from the type of that species (which was described from a single female) in having the color of thorax and abdomen decidedly green, not bronze brown as in brunneus; the bend in the last section of fourth vein is sharper in this male and slightly nearer its middle, and the middle basitarsi have two bristles on upper edge (there is only one on one basitarsus in the type, but one may have been broken off) in this species, while in brunneus there is none. The middle tibiae in both forms have one bristle below.

The name was suggested by the small hypopygium which reminded me of a rabbit's tail.

No. 99. DOLICHOPUS BRUNNEUS Aldrich.

Dolichopus brunneus Aldrich, Kansas Univ. Quart., vol. 2, p. 14, 1893.

Female.—Length 3 mm.; of wing 2.8 mm. Face broad, with grayish white pollen which is slightly tinged with yellow near the antennae. Front dark green, somewhat shining. Antennae wholly black; third joint scarcely longer than wide, somewhat pointed at tip. Lower orbital cilia pale.

Thorax and abdomen bronze-brown; dorsum of thorax a little dulled with brown pollen; pleurae more black with white pollen.

Fore coxae yellow, blackened at base on outer surface, the black not sharply limited but shading into the yellow; anterior surface with little black hairs. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle. Posterior tibiae blackish at tip, slightly thicker than the others. Middle tibiae with one bristle below. Fore tarsi about as long as their tibiae, black from the tip of the first

joint, which is scarcely as long as the remaining four joints taken together; third and fifth joints of equal length, about two thirds as long as the second and a very little longer than the fourth. tarsi about one and a fourth times as long as their tibiae, black from the tip of the first joint, which has no bristle on its upper surface. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 99) tinged with brownish gray; costa rather thick from the tip of the first vein and tapering to its tip, still the costa could not be called enlarged at tip of first vein; last section of fourth vein only slightly bent at a point beyond its basal third; hind margin of wing scarcely indented at tip of fifth vein, rather evenly rounded, the anal angle not being developed.

Redescribed from the single female type specimen, which was taken by J. M. Aldrich at Brookings, South Dakota, June 18, 1891, and is in his collection.

No. 100, DOLICHOPUS RAMIFER Loew.

Dolichopus ramifer LOEW, Neue Beitr., vol. 8, 1861, p. 19; Mon. N. Amer. Dipt., pt. 2, 1864, p. 52.—Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 12.— Melander and Brues, Biol. Bull., vol. 1, 1900, p. 148.—Johnson, Insects of New Jersey, 1909, p. 756.

Male.—Length 3-4.5 mm.; of wing 3-4 mm. Face wide, white, a little narrowed below. Front bluish black, usually with purple reflections, very shining. Antennae black; first joint usually a little yellowish on the lower apical corner; third joint nearly two and a half times as long as wide, nearly straight above, broadly rounded below, pointed at tip, arista inserted a little before the point. Palpi yellow. Lateral and inferior orbital cilia whitish, a few of the upper cilia black.

Dorsum of thorax and the abdomen dark bronze brown with slight green or reddish coppery reflections; pleurae more green with whitish pollen, one male from Colorado is wholly dark shining green, second and third abdominal segments with conspicuous white hairs on their sides. Hypopygium black, short and stout; its lamellae (fig. 100a) small, somewhat triangular or perhaps they could be called crescent-shaped, whitish with a narrow black border on the rounded apical margin, which is scarcely jagged but fringed with brown hairs.

Fore coxae yellow, blackened at base on outer side, anterior surface with little black hairs. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle femora usually with two, hind femora with one preapical bristle, the latter ciliated on lower inner edge with a few delicate whitish hairs, the longest of which are nearly as long as the width of the femora. Posterior tibiae thickened, black at tip for one fourth their length; the usual glabrous stripe between the large bristles although rather wide is somewhat broken by little black hairs, on basal half of inner surface the little black hairs become so small as to give it the appearance of being glabrous; bristles on upper surface large. Fore tarsi a little longer than their tibiae, black from the tip of the first joint, which is about as long as the three following joints taken together, second joint only a little longer than third, this and fifth of about equal length, fourth a little shorter. Middle tarsi one and a fourth times as long as their tibiae, black from the tip of the first joint, which is without a bristle above. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 100) grayish; costa scarcely enlarged at tip of first vein; last section of fourth vein bent at right angles at its middle, upper bend rounded, lower bend with more or less of a stump of a vein (which suggested the name); hind margin of wing scarcely indented at tip of fifth vein, rather evenly rounded, the anal angle being rather prominent.

Female.—Like the male, except that the face is a little wider, third antennal joint about half as large, and the middle femora usually have but one bristle before the tip.

Redescribed from numerous males and females from the following localities: Brookings, South Dakota; Michigan; Montana; Idaho, several places, July-August; Lafayette and Shelby, Indiana, May 24–July 26 (Aldrich); Iowa (Osborn); Greeley, Colorado, August 31; Lance Creek, Sheridan and Natrona County, Wyoming, August 14–31 (Wheeler); Wells, Nevada, June 6; Lawrence and Baldwin, Kansas, May; western New York, May 21–September 19; southern Ontario, rfom Toronto to Chatham, May 30–July 3; Colorado Springs, Colorado, June 10; Illinois; Sandusky, Ohio, June 30; Los Angeles, California, May 3; Washington, several places, July to August. I have found it abundant in greenhouses around Buffalo, New York, in February and March.

Type localities.—Nebraska; Lake Winnipeg; New Rochelle, New York. Aldrich reports it from Michigan, Montana, Kansas, and Idaho. Chagnon from Montreal, Quebec. Melander and Brues from Illinois, Texas, and Wyoming. Johnson, Insects of New Jersey, from Monmouth County, and Avalon, New Jersey, August 22–31.

No. 101. DOLICHOPUS INCISURALIS Loew.

Dolichopus incisuralis Loew, Neue Beitr., vol. 8, 1861, p. 25; Mon. N. Amer. Dipt., pt. 2, 1864, p. 74; Centuries, vol. 7, 1866, No. 80 (platyprosopus).—
Johnson, Insects of New Jersey, 1909, p. 756.

Male.—Length 3-4.5 mm.; of wing 3.5-4 mm. Face rather narrow, silvery white. Front shining green. Antennae black; first joint reddish below; third rather small, about as long as broad, somewhat

pointed at tip. Lateral and inferior orbital cilia pale, about five of the upper cilia on each side black.

Thorax shining green with coppery reflections on the anterior part of the dorsum where there is a little white pollen; pleurae dulled with whitish pollen. Abdomen green with black incisures and considerable white pollen, which is more conspicuous along the sides. Hypopygium black; its lamellae moderately large, somewhat oval in outline, white with a narrow black border, jagged and bristly at apex.

Fore coxae yellow with a small blackish spot at base on outer side. anterior surface with little black hairs on inner edge and sometimes at base and minute yellow hairs on outer edge. Middle and hind coxae black with yellow tips; sometimes the posterior pair are yellow on inner side. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the hind ciliated with delicate yellow hairs on the lower inner edge, these hairs about half as long as the width of the femora. Posterior tibiae black at tip, slightly thickened; on inner surface there is a glabrous stripe inside of the inner row of large bristles which near the base covers almost the whole width of the tibia. Fore tarsi nearly one and a half times as long as their tibiae, infuscated from the tip of the first joint, first, and second joints taken together nearly as long as the tibiae, second about half as long as first and a little longer than third; fourth and fifth of nearly equal length, each being a little shorter than the third, still the fifth is a little the shortest. Middle tarsi a little more than one and a fourth times as long as their tibiae, black from the tip of the first joint, which is without a bristle above. Hind tarsi wholly black. Calvpters and halteres yellow, the former with black cilia.

Wings (fig. 101) tinged with gray; costs scarcely enlarged at tip of first vein; last section of fourth vein a little bent some distance beyond its basal third; hind margin of wing scarcely indented at tip of fifth vein, rather evenly rounded, the anal angle being rounded, not very prominent.

Female.—Face wide, white; fore tarsi not or but little longer than their tibiae, and with the fifth joint a little longer than the fourth; otherwise about as in the male. Middle tibiae with one bristle below.

Redescribed from the type specimens and 7 males. Two of the latter were taken at Ithaca, New York; 1 at Colden, Erie County, New York, July 23; 1 at Niagara Falls, Ontario (Van Duzee), July 20, and 2 at Turkey Run, Indiana (Aldrich), August 20, 1918.

Type locality.—Trenton Falls, New York; the type of platyrosopus was from Hudson Bay Territory. Chagnon reports it from Montreal, Quebec. Insects of New Jersey, from Merchantville, New Jersey, June 28.

Synonymy by Aldrich, Catalogue, 1905, from types.

Types.—In Museum of Comparative Zoology, Cambridge, Massachusetts.

No. 102. DOLICHOPUS MELANOCERUS Loew.

Dolichopus melanocerus Loew, Cent., vol. 3, No. 86; Mon. N. Amer. Dipt., pt. 2 p. 330.—Melander and Brues, Biol. Bull., vol. 1, p. 148.

Male.—Length 4 mm.; of wing the same. Face rather wide, covered with coarse yellow pollen. Front shining green, sometimes coppery in the center. Antennae wholly black; third joint oval, about one and a fourth times as long as wide, usually broadly rounded at tip, but sometimes quite pointed. Lateral and inferior orbital cilia whitish, a few of the upper cilia black.

Thorax shining green with coppery reflections, especially between the acrostichal bristles; pleurae dulled with grayish pollen. Abdomen shining green with black incisures and coppery reflections, its sides dulled with white pollen. Hypopygium black; its lamellae (fig. 102a) of moderate size, oval or subquadrilateral in outline, whitish with wide black border on the apical margin, which extends narrowly along the upper and lower edges, jagged and bristly at apex, fringed with rather long brown hairs on upper edge.

Fore coxae yellow with a rather large blackish spot at base on outer side, their anterior surface clothed with minute blackish hairs, which appear yellowish in certain lights. Middle and hind coxae black almost to their tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the former also has a small bristle on the posterior side near the tip in the type specimen, the latter ciliated on lower inner edge with yellow hairs, the longest of which are about as long as the width of the femora. Posterior tibiae with black tips, the glabrous stripe on upper surface broad and extending upon the inner side which is largely glabrous. Fore and middle tarsi one and a fourth times as long as their tibiae, black from the tip of the first joint. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 102) tinged with brownish gray; costa with a small knotlike enlargement at tip of first vein; last section of fourth vein bent before its middle; hind margin of wing only slightly indented at tip of fifth vein; anal angle rounded, not at all prominent.

Female.—Face twice as wide as in the male, whitish, tinged a little with yellow on the upper part; third antennal joint about as long as wide; hind femora without cilia; the glabrous stripe on hind tibiae confined to the space between the rows of large bristles; costa without enlargement; the fore coxae are blackened at base as in the male; otherwise as in the male.

Redescribed from the single type specimen and 5 males and 2 females taken as follows: 2 males and 1 female at New Bedford, Massachusetts (Hough), May 20, 1896; 1 male at Montreal, Quebec, July 7, 1906; 2 males at Kearney, Ontario, July 29, 1911, and 1

female at the same place July 5, 1909 (Van Duzee); 1 male at Sudbury, Ontario, July 22, 1915.

Tupe locality.—"Canada." Melander and Brues report it from Massachusetts.

This species is closely related to pantomimus Melander and Brues, but differs in having the anal angle of the wing rounded off, not at all prominent, fore coxae with a blackish spot at base; the lamellae of the hypopygium are oval or almost quadrilateral in outline; while in pantomimus they are more triangular in form, the fore coxae are wholly yellow in all the specimens I have seen, and the anal angle of the wing is quite prominent.

No. 103, DOLICHOPUS PANTOMIMUS Melander and Brues.

Dolichopus pantomimus Melander and Brues, Biol. Bull., vol. 1, 1900, p. 142.— ALDRICH, Cat. N. Amer. Diptera, 1905, p. 303.

Male.—Length 3.5-4.5 mm.; of wing 3-3.5 mm. Face rather narrow, golden yellow. Front shining green. Antennae wholly black; third joint large, about twice as long as wide, pointed at tip, arista inserted a considerable distance before its tip. Lateral and inferior orbital cilia yellowish, about six of the upper cilia on each side black.

Dorsum of thorax shining green, sometimes with a median coppery vitta, (in one specimen this median line is deep blue), and with a little white pollen along the anterior edge; pleurae dulled with whitish pollen. Abdomen shining green, sometimes with slight coppery reflections, with black incisures and white pollen, which forms spots on the sides of the segments. Hypopygium black; its lamellae (fig. 103a) of moderate size, somewhat triangular in outline, but with the apical margin rounded, jagged and bristly, whitish with a rather wide, black, apical border.

Fore coxae wholly yellow with minute pale hairs on the anterior surface. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter ciliate on their lower inner edge with pale hairs for three-fourths their length, these hairs placed at regular but rather wide intervals and scarcely as long as the width of the femora. Posterior tibiae black at tip; the glabrous stripe on upper surface wide, extending upon the inner side of the tibiae. Fore and middle tarsi yellow, more or less darkened toward their tips. Fore tarsi one and a fourth times as long as their tibiae, the joints of regularly decreasing length. Middle tarsi one and a third times as long as their tibiae, first joint without a bristle. Middle tibiae with one small bristle below. Hind tarsi wholly black. Calypters and halteres yellow, the latter with black cilia.

Wings (fig. 103) tinged with brownish gray; costa with a knotlike enlargement at tip of fifth vein; last section of fourth vein a little bent near its basal third; hind margin of wing not indented at tip of fifth vein; anal angle prominent.

Redescribed from the type specimen and 8 males. Two of the latter were taken by C. W. Johnson at Niagara Falls, New York, June 23; I took 3 at Niagara Falls, Ontario, July 31, 1910; R. C. Shannon took 1 at Dead Run, Fairfax County, Virginia, June 22, 1915; and 2 were taken at Plummers Island, Maryland, May 9, 1914.

Type locality.—New Bedford, Massachusetts.

Type.—In American Museum of Natural History.

No. 104. DOLICHOPUS FLAVICILIATUS, new species.

Male.—Length 4 mm.; of wing the same. Face rather narrow, being narrowest below, brownish, in the type almost black near the antennae, only a little silvery at its extreme lower edge. Front shining green. Antennae (fig. 104a) wholly black, second joint small; third large, twice as long as wide, rather obliquely cut off at tip so as to form a point at upper apical angle; arista about as long as the antenna and inserted near apical third of third joint. Lateral and inferior orbital cilia yellowish, a few of the upper cilia black.

Thorax dark green, not very shining; pleurae dulled with gray pollen. Abdomen green; last two segments with coppery reflections; the white pollen on its sides conspicuous. Hypopygium black; its lamellae (fig. 104b) of moderate size, somewhat oval in outline, a little longer than wide, with a small notch near the middle of the apical margin, which cuts nearly through the black border, below this the apical margin is jagged and bristly, above and on upper edge they are fringed with rather long fine hairs.

Fore coxae yellow, with a large blackish spot at base on outer side, anterior surface with delicate yellow hairs, a few minute black ones near the tip on inner edge. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter ciliated with yellow hairs as long as the width of the femora, on lower inner edge for two thirds their length, and with long black hairs on upper edge. Posterior tibiae black at tip for one-fifth their length, thickened, glabrous on most of their inner side, except on apical fourth. Fore and middle tarsi about one and a fourth times as long as their tibiae, black from the tip of the first joint, first joint of each as long as the two following taken together; fifth joint of fore tarsi longer than tibiae the fourth; middle basitarsi without a bristle above, their with one bristle below. Calypters, their cilia and the halteres yellow.

Wings (fig. 104) slightly grayish; costa with a knotlike enlargement at tip of first vein; last section of fourth vein bent at its middle,

hind margin of wing scarcely indented at tip of fifth vein but slightly bulging just before this point and very slightly hollowed between there and the tip of sixth vein; anal angle not very prominent.

Described from 1 male taken by H. S. Parish at Waubamic, Ontario, July 14, 1915.

Type in the collection of A. L. Melander. It met with an accident after the description was written and is in poor shape, the fore legs being broken off.

No. 105. DOLICHOPUS DECORUS, new species.

Male.—Length 4.5 mm.; of wing 5 mm. Face wide, covered with coarse gray pollen, which is tinged a little with yellow. Front shining blue-green. Antennae black; lower half of first joint vellow; third joint large, nearly twice as long as wide, nearly straight above, rounded below, pointed at tip, arista inserted about the middle of the upper edge. Lower orbital cilia yellowish white, about 10 of the upper cilia on each side black.

Thorax blue-green with bronze reflections which form three poorly defined vittae on the fore part of the dorsum, which is covered with yellowish gray pollen; pleurae dulled with gray pollen. Abdomen green with coppery reflections and narrow black incisures, somewhat dulled with white pollen, which is no thicker on the sides than on the upper surface. Hypopygium black, its lamellae large, oval, jagged and bristly on apical margin, white with a narrow black border on apical and upper margins, fringed on upper edge with black hairs.

Fore coxae vellow with a black spot at base on outer side, their anterior surface covered with thin silvery pollen and with little black hairs. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter ciliated on apical half of the lower inner edge with yellow hairs, the longest of which is scarcely as long as the width of the femora. Posterior tibiae a little thickened, their tips black for one-sixth their length; the glabrous stripe on upper surface between the rows of large bristles distinct but not quite reaching their base, basal third of inner surface also glabrous. Fore tarsi about one and a third times as long as their tibiae, black from the tip of the first joint, which is as long as the two following joints taken together; middle tarsi a little longer than their tibiae, black from the tip of the first joint, which has a large bristle above near apical fourth. Middle tibiae with three bristles below, two near apical third and one at basal third. Hind tarsi wholly black, one and a fourth times as long as their tibiae. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 105) uniformly tinged with brownish gray; costa a little thickened just before the tip of first vein and tapering to its tip, still this enlargment is a little more conspicuous just at the tip of first vein; last section of fourth vein rather sharply bent at its middle and ending a little before the apex of the wing; third vein bent backward toward its tip, still the tips of third and fourth vein widely separated; hind margin of wing indented at tip of fifth vein, rather evenly rounded, the anal angle being but little developed.

Female.—Face wide with coarse white, almost silvery pollen; fore coxae sometimes wholly yellow; hind coxae largely yellow, sometimes almost wholly so; middle tibiae and tarsi as in the male; wings as in the male.

Described from 1 male and 3 females. The male was taken at Algonquin, Illinois (Nason); 2 females were taken at Battle Creek, Michigan (Aldrich); 1 female at Buffalo, New York, June 10, 1908 (Van Duzee).

Type.—Male, Cat. No. 23027, U.S.N.M.

The male and female of this species can easily be separated from those of *setosus* Loew by the three bristles on the lower surface of the middle tibiae and the large bristle on upper edge of the middle basitarsi; in *setosus* there is only one bristle on the lower edge of the middle tibiae and no bristle at all on the middle basitarsi. This last character is the most constant one.

No. 106. DOLICHOPUS SETOSUS Loew.

Dolichopus setosus Loew, Cent., vol. 2, 1863, p. 63; Mon. N. Amer. Dipt., pt. 2, 1864, p. 73.

Male.—Length 4.5-5 mm.; of wing the same. Face rather narrow, narrowest below, silvery white. Front blue or violet, shining. Antennae black; first joint yellow below; third joint rather large, longer than wide, somewhat conical in outline, a little pointed at tip. Lateral and inferior orbital cilia yellowish white, about six of the upper cilia on each side black.

Thorax green, sometimes almost violet; dorsum with a little gray pollen on its anterior portion, which sometimes has bronze reflections; pleurae with a little gray pollen. Abdomen green with bronze and sometimes blue reflections; the white pollen on its sides abundant. Hypopygium black; its lamellae (fig. 106a) moderately large, somewhat triangular in outline with the upper apical corner rounded, whitish with a black apical border, jagged and bristly at lower apical corner, otherwise the apical margin is fringed with long blackish hairs.

Fore coxae yellow with a small brownish spot at base on outer side, anterior surface with white pollen, its inner half with black hairs, on outer half the hairs are mostly yellow. Middle and hind coxae

black with yellow tips, femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter ciliated below with long delicate hairs for their entire length, those on basal third rather short; the longest of the hairs are nearly twice as long as the width of the femora and a little wavy at tip. Posterior tibiae black at tip for one-sixth their length, a little thickened; the glabrous stripe on upper edge quite distinct but not reaching the tip; most of the inner surface is glabrous, but this narrows apically. Fore tarsi about one and a fourth times as long as their tibiae, black from the tip of the first joint, which is about as long as the three following joints taken together, all the joints of regularly decreasing length. Middle tarsi a little longer than their tibiae, black from the tip of the first joint, their basitarsi without a bristle above. Middle tibiae with one long bristle below. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 106) grayish; costa with a small knotlike enlargement at tip of first vein; last section of fourth vein bent two-fifths its length from its base, from which point it is very nearly parallel with fourth; hind margin of wing a little indented at tip of fifth vein, rather evenly rounded, the anal angle not being very prominent.

Female.—Face wide, silvery gray; third antennal joint about as wide as long, nearly round in outline, but pointed at tip; fore tarsi black from the tip of the first joint, still the base of the second is a very little yellow; wings as in the male, except that there is no enlargement of the costa at tip of first vein; middle tibiae with one long bristle below, their basitarsi without a bristle.

Redescribed from the single type specimen, which is from Massachusetts; 1 male from the Osten Sacken collection, taken at New York; 1 male taken at East Aurora, New York, June 11, 1911; 1 male from Woods Hole, Massachusetts; 1 male taken at New Bedford, Massachusetts; and 1 female taken at Ridgeway, Ontario, June 6, 1909.

The female on the same pin as the type is not the same species, one female standing with these marked "setosus?" is the female of flagellitenens Wheeler; another female standing with the Osten Sacken male may be this species but has no head.

Type.—In Museum of Comparative Zoology, Cambridge, Massachusetts.

No. 107. DOLICHOPUS SERRATUS, new species.

Male.—Length 5.2 mm.; of wing 5 mm. Face rather wide, narrower on lower half, silvery white. Front shining green. Antennae black; first joint yellow below, especially at apex; third joint oval, a little longer than wide, rather rounded at tip. Lateral and inferior orbital cilia whitish, about six of the upper cilia black.

Thorax shining green with bronze reflections, which form broad poorly defined vittae on the dorsum, which has yellowish white pollen along the front; pleurae dulled with white pollen. Abdomen shining green with coppery reflections, especially on the apical segments; the white pollen of the sides abundant and extending thinly over the dorsum. Hypopygium black; its lamellae moderately large, somewhat quadrangular in outline, being cut off rather squarely at apex, and widening out rather abruptly from the stem on upper edge at base, yellowish white with a narrow black border on apical and upper margins, jagged and bristly along the apical end, fringed above with rather long dark hairs, below with delicate pale hairs.

Fore coxae vellow with a brown spot at base on outer side; anterior surface with silvery white pollen, clothed with delicate pale hairs on outer half and little black hairs on inner half. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter ciliate with vellowish hairs on apical two thirds of lower inner edge, the longest of these hairs fully as long as the width of the femora and near its apex. Posterior tibiae deep black for one-fourth their length, a little thickened; the glabrous stripe on upper surface narrow, a wider glabrous stripe on the inner surface does not reach the base and is separated from the one on upper edge by the inner row of large bristles between which are little hairs. Fore and middle tarsi black from the tip of the first joint, the former one and a fourth, the latter one and a third times as long as their tibiae, rather stout; first joint of fore tarsi about as long as the remaining four taken together, second, third, and fourth a little narrowed at base so as to give the tarsi a serrated appearance; middle basitarsi brownish almost to their base, without a bristle above, their tibiae with one bristle below. Hind tarsi wholly black, nearly one and a half times as long as their tibiae. Calypters and halteres yellow, the cilia of the latter reddish yellow, but in certain lights appearing black.

Wings (fig. 107) grayish; costa stout, a little enlarged at tip of first vein, gradually tapering to its tip; last section of fourth vein bent a little beyond its basal third, its tip widely separated from the tip of third, which bends backward; hind margin of wing a little indented at tip of fifth vein, rather evenly rounded, the anal angle not being very prominent.

Described from 1 male taken on the summit of Mount Katahdin, Maine, at 5,215 feet elevation, on August 19, 1902, and 1 male taken at Wyandarch, Long Island, New York, July 1, 1910, by W. T. Davis.

Type.—Male, Cat. No. 23028, U.S.N.M., from Maine.

No. 108. DOLICHOPUS RENIDESCENS Melander and Brues.

Dolichopus renidescens MELANDER and BRUES, Biol. Bull., vol. 1, p. 143.

Male.—Length 4.5-5 mm.; of wing the same. Face very wide and short, yellowish brown. Front violet, green along the orbits and lower edge, sometime wholly blue-green, shining. Antennae wholly black; third joint a little longer than wide, obtusely pointed at tip; palpi dark yellow with black hairs. Lateral and inferior orbital cilia white, about six to eight of the upper cilia on each side black.

Thorax dark shining green, still the dorsum is slightly dulled with almost invisible brown pollen; pleurae dulled with white pollen. Abdomen dark green with slight bronze reflections and a little white pollen on its sides. Hypopygium black; its lamellae (fig. 108a) of moderate size, somewhat triangular in outline, white with wide black border on apical margin, which is jagged and bristly.

Fore coxae yellow with a blackish spot at base on outer side, their anterior surface with rather numerous black hairs. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with two preapical bristles, placed one before the other, the latter ciliated on apical half of lower inner edge with long black hairs, the hairs being inserted rather widely apart, the longest about as long as the width of the femora. Posterior tibiae a little thickened, black at tip, more extensively so on inner side, where the black sometimes reaches three-fourths their length, the vellow usually reaching the tip on the lower surface; on most of the inner surface the hairs are very minute, giving it the appearance of being glabrous. Fore tarsi a little longer than their tibiae, black from the tip of the first joint, which is nearly as long as the three following joints taken together, fifth joint shorter than third and longer than fourth. Middle tarsi one and a fourth times as long as their tibiae, black from the pit of the first joint, which is without a bristle above. Middle tibiae with a large bristle before apical third and two small ones just before it on the lower surface. Hind tarsi fully one and a half times as long as their tibiae, wholly black. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 108) grayish, usually strongly tinged with brown in front of third vein; costa with small enlargement at tip of first vein; last section of fourth vein a little bent before its middle; hind margin of wing a little indented at tip of fifth vein; wings of rather parallel width, still a little narrowed from tip of sixth vein to the anal angle. which is prominent; the hind margin is a little sinuous between the tips of fifth and sixth veins, forming a small lobe near sixth.

Female.—Face nearly the same width as in the male, yellowish gray; hind femora without cilia below; hind tibiae a little thickened,

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not much blackened at tip; hind margin of wing more rounded, making the wing wider in the middle than it is in the male; anal angle rounded, not very prominent, veins slightly bordered with brown; costa not enlarged at tip of first vein. The bristles of the middle tibiae and tarsi and middle and hind femora as in the male.

Redescribed from 8 males and 2 females. These were taken at the following locations: Hagerman, and Craigs Mountain, Idaho; South Dakota; Bottineau, North Dakota, June 20, 1918—all taken by J. M. Aldrich; Bozeman, Montana, June 4, 1911; Colorado, taken by Baker; 1 male taken at Dauphin, Manitoba, June 22, 1912, by Dr. E. M. Walker, and 1 male at Nelson, British Columbia, July 1, 1910.

Type.—In American Museum of Natural History; from North Park, Colorado.

No. 109. DOLICHOPUS HASTATUS Loew.

Dolichopus hastatus Loew, Mon. N. Amer. Dipt. pt. 2, 1864, p. 59.—Aldrich Kansas Univ. Quart., vol. 2, 1893, p. 13.

Male.—Length 5 mm.; of wing the same. Face rather wide and long, a little narrowed in the middle, pale golden yellow. Front green with bronze reflections and a little yellowish pollen along the orbits. Antennae (fig. 109a) yellow; third joint brown on apical half or more, somewhat orbicular in outline; arista inserted in a notch on upper edge of third joint, black, its basal joint long and seems to form two thirds of the arista, the remainder seems to be jointed at its basal third, from which joint it is compressed into a fusiform lamella, which is whitish at tip and fringed above and below with minute hairs on its edges, making it appear much wider; this lamella occupies about half the length beyond the basal joint. Proboscis brown; palpi yellow. Lateral and inferior orbital cilia pale yellow, about ten of the upper cilia on each side black.

Thorax green, dorsum with the beginings of two dull coppery vittae in front, and dulled with almost invisible brownish pollen, except along the front edge, where the pollen is gray; pleurae dulled with white pollen. Abdomen green with black incisures and slight bronze reflections; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black; its lamellae of moderate size, oval in outline, longer than wide, yellowish white, sometimes quite yellow or almost yellowish brown, with a black border, which is wide on apical, narrow on upper margin, jagged and bristly at apex, fringed with delicate black hairs above,

Fore coxae yellow with a small brown spot at extreme base on outer side; anterior surface clothed on all but its outer edge with little black hairs; the outer edge appears glabrous. Middle and hind coxae black with yellow tips. Femora and tibae yellow. Middle and hind femora each with one preapical bristle, the hind not ciliated

below, but with the little black hairs on the sides reaching the lower edge. Middle tibiae with their tips a little enlarged and black, also with a preapical brown ring, between which and the black of the tip is a glabrous, shining, white spot on their upper side. Hind tibiae only slightly thickened, blackish at tip, especially below; the glabrous stripe on upper surface distinct, but broken by a few hairs and not reaching either base or tip; inside of the inner row of large bristles there is also a narrow glabrous line, which is widest toward the base and reaches the tip, but is broken by a few little hairs where the infuscation of the tip begins. Fore tarsi about equal to their tibiae in length, black from the tip of the first joint, which is about as long as the three succeeding joints taken together, fifth a little shorter than the fourth. Middle tarsi about equal to their tibiae in length; last three joints distinctly, although only slightly, compressed, black; first joint black at base and tip, yellow in the middle. Hind tarsi one and a third times as long as their tibiae, black from the tip of the first joint, rather stout, almost imperceptibly compressed; first joint sometimes blackened at base below and furnished with but two large bristles above. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 109) gravish, tinged with brownish in front and along the veins; costa not enlarged at tip of first vein; last section of fourth vein bent near one-third its length; third vein bent backward a little at tip; hind margin of wing scarcely indented at tip of fifth vein, from this point to the tip of sixth vein is a deep bisinuate excision which leaves a prominent lobe at anal angle.

Female.—Face wide and short, almost brown; arista about normal, its basal joint being about one-third of its length; front green or blue-green; middle tibiae yellow with the tip slightly enlarged and tinged with brown; there is a small glabrous spot on upper side at about basal third: middle tarsi very slightly compressed: all tarsi black from the tip of the first joint; hind tibiae only slightly brownish at tip and without any glabrous line inside of the inner row of bristles; wings rather broadly and evenly rounded on their posterior margin; anal angle prominent.

Redescribed from 4 males and 10 females taken by J. M. Aldrich on the top of Mount Constitution, Orcas Island, Washington (2,400 feet), July 7, 1905, and July 17, 1909; 1 male taken at Ilwaco, Washington, July, 1917, by A. L. Melander; and 1 male and 2 females taken at Eureka, California, May 22 to June 6; R. P. Currie took a female at Kaslo, British Columbia, June 10.

Type locality.—Sitka, Alaska. J. M. Aldrich reports it from Mount Hood, Oregon.

No. 110. DOLICHOPUS COMPTUS, new species.

Male.—Length, 5 mm.; of wing the same. Face wide, covered with yellowish gray pollen. Front blue-green with a little yellowish pollen along the orbits. Antennae (fig. 110a) yellow; third joint nearly orbicular in outline, its apical half blackish; arista inserted in a notch on upper edge of third joint, black, the tip with a fusiform enlargement, which is about one-third of the length of arista and is fringed on both upper and lower edges with minute hairs; this enlarged tip forms a distinct joint to the arista; proboscis blackish; palpi yellow. Lateral and inferior orbital cilia pale yellow, about eight of the upper cilia on each side black.

Thorax green with coppery reflections and a little yellowish pollen on the anterior part of the dorsum; pleurae dulled with white pollen. Abdomen green with slight bronze reflections. Hypopygium black, short; its lamellae small, somewhat oval in outline, but tapering into the stem, about one and a fourth times as long as wide, yellowish with a black border on the rounded apical margin, which is a little jagged and bristly at its upper corner, otherwise fringed with black hairs.

Fore coxae yellow, with only a trace of brown at base on outer side, their anterior surface clothed with stiff black hairs, except at base on outer edge where there are a few pare hairs. Middle and hind coxae black with yellow tips. All trochanters with a small brown spot below. Femora and tibiae vellow. Middle and hind femora each with one preapical bristle, the latter without cilia below, the little black hairs on their sides reaching the lower edge. Fore tibiae slightly, the middle and hind ones conspicuously brown at tip. Middle tibiae also with a faint brownish ring near apical third and with a narrow glabrous line on upper surface, which expands a little beyond the brown ring, so as to form a small glabrous spot. terior pair thickened; the glabrous stripe on upper surface distinct, but it does not reach either base or tip. All tarsi wholly black, except the first joint of fore tarsi, which is yellowish below. Fore and middle tarsi stout, very slightly compressed, a little longer than their tibiae, the first joint being about as long as the three succeeding joints taken together; middle basitarsi without a bristle above. Calvpters and halteres vellow, the former with black cilia.

Wings (fig. 110) grayish, very slightly darker in front of second vein; costa not enlarged at tip of first vein; last section of fourth vein bent before its middle; third vein bent backward a little toward its tip; hind margin of wing a little indented at tip of fifth vein; the wing widest just back of this point; wing with a large lobe from the tip of sixth vein to the anal angle.

Described from 1 male taken at Tallac Lake, Tahoe, California, July 3, 1915, by E. P. Van Duzee.

This differs from hastatus Loew in having the lamella on the arista longer; the hypopygium is much shorter and the lamellae are very much smaller than in hastatus; the wing has nearly the same lobe at the anal angle, but here the hind margin is nearly straight between the tips of fifth and sixth veins, while in hastatus it is deeply sinuous between these points.

The two species resemble each other very much in the form and color of the antennae and arista, the lobe at tip of sixth vein, the color of middle tibiae and the glabrous spot on their upper surface.

This is another example of the remarkable grouping of two or more species with several prominent and striking characters in common and yet with good distinguishing points by which to separate them, which we meet in this genus.

Type.—In California Academy of Sciences.

No. 111. DOLICHOPUS DORSALIS, new species.

Male.—Length 5.7 mm.; of wing 5.5 mm. Face rather wide, narrowed a little below, silvery white. Front green, with white pollen along the orbits. First antennal joint yellow, second mostly yellow, but blackened at tip; third wholly black, about as long as wide, somewhat orbicular in outline, still a little pointed at tip. Lateral and inferior orbital cilia vellowish white, about five of upper cilia black.

Thorax green, dorsum with a narrow median and wide lateral coppery vittae, considerably dulled with thick yellowish gray pollen. Abdomen green with coppery reflections; white pollen on its sides abundant and extending over the dorsum. Hypopygium black; its lamellae large, somewhat triangular in outline, but with the upper corner rounded, whitish with a moderately wide black border on the apical margin, which is jagged and bristly, more deeply so at lower corner.

Fore coxae wholly yellow, their anterior surface covered with white pollen and minute black hairs, which are mixed with delicate vellow ones on outer half. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter bare below. Posterior tibiae a little infuscated on inner side at tip; the usual glabrous stripe on upper surface between the two rows of large bristles distinct but somewhat broken by a few little hairs. Middle tibiae with three bristles below, a pair at apical third and one at basal third; they have three quite distinct glabrous spots on upper side. Fore tarsi a little longer than their tibiae, yellow, a little infuscated toward the tip, fifth joint almost black; first joint a little longer than the following two taken together, second half as long as first, third and fifth of about equal length, fourth a little shorter. Middle tarsi black from the tip of first joint, which is brownish; it has a large bristle on upper surface beyond its middle. Hind tarsi missing in the type, but no doubt they would be wholly black as in other species with blackened tips to the tibiae. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 111) grayish, slightly tinged with brown in front of second vein and narrowly along the fourth and cross veins; costa a very little thickened from before the tip of the first vein, gradually tapering to its tip; last section of fourth vein a little bent near its basal third, being about as far from the cross-vein as the length of that vein; hind margin of wing a little indented at tip of fifth vein; wing narrowing from a little beyond the tip of fifth vein to the anal angle, which is still rather prominent as the hind margin does not round off to the root of the wing.

Described from 1 male taken on rocks by the side of a stream on the White Mountains, New Mexico, at Rio Ruidoso, at 6,500 feet elevation (Townsend).

Type.—Male, Cat. No. 23029, U.S.N.M.

No. 112. DOLICHOPUS ABRASUS, new species.

Male.—Length 4.5 mm.; of wing the same. Face rather wide and long, silvery white. Front shining green. Antennae yellow, third joint with apical half brown, a little longer than wide, obtusely pointed at tip. Palpi yellow. Lateral and inferior orbital cilia white, about eight of the upper cilia on each side black.

Thorax shining green with brassy reflections and yellowish gray pollen on the dorsum, which does not dull it much, the bristles inserted in little black dots; pleurae dulled with white pollen. Abdomen green with conspicuous coppery reflections; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black; its lamellae (fig. 112) large, oval, nearly twice as long as wide, whitish with a black border on apical and part of upper margin, jagged and bristly at apex, fringed with delicate hairs above.

All coxae yellow; fore coxae almost glabrous on the front surface, still with a few very delicate yellow hairs. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter glabrous below. Posterior tibiae but little thickened, blackened on their apical half, the black shading into the yellow; the usual glabrous stripe on upper surface appears as a yellowish stripe between the rows of large bristles, it does not quite reach the base or tip. Fore tarsi about one and a fourth times as long as their tibiae, somewhat infuscated from their base, but only the fifth joint black; first joint as long as the three following joints taken together, fourth about two-thirds as long as third, fifth fully as long as fourth and a little wider, being slightly enlarged. Middle tarsi infuscated from their

base, especially below. Hind tarsi black; first joint rather slender for a Dolichopus and with two large bristles on upper surface. Calypters and halteres vellow, the former with black cilia.

Wings grayish, more yellowish brown in front of third vein; costa not enlarged at tip of first vein; last section of fourth vein a little bent before its middle; hind margin of wing scarcely indented at tip of fifth vein, rather evenly rounded, the anal angle not being very much developed.

Described from 1 male which I took on Grand Island, Erie County, New York, August 17, 1913.

Type.—Male, Cat. No. 23030, U.S.N.M.

No. 113. DOLICHOPUS MARGINATUS Aldrich.

Dolichopus marginatus Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 17.-MELANDER and BRUES, Biol. Bull., vol. 1, 1900, pp. 135 and 148.

Male.—Length 5.5-6 mm.; of wing 4.2-5 mm. Face rather wide, white, sometimes more grayish. Front violet with a narrow green edge above the antennae and along the orbits. First and second antennal joints yellow, usually with the upper edge very narrowly black; third joint black with the base or even half vellow, somewhat conical in outline, but little longer than wide, obtusely pointed at tip. Lateral and inferior orbital cilia pale yellow; about seven of the upper cilia on each side black.

Thorax shining green with bronze reflections, which often form a median vitta on the dorsum; pleurae dulled with white pollen. Abdomen green with coppery reflections on the hind margins of the segments. Hypopygium black; its lamellae (fig. 113) rather large, somewhat orbicular in outline, white with a rather wide, sharply defined black border on apical margin, jagged and bristly at lower apical corner, otherwise fringed on apical and upper margins with very long curved black hairs.

Fore coxae yellow with a blackish spot at base on outer side, anterior surface with black hairs except at upper outer corner, where the hairs are vellow. Middle and hind coxae vellow on inner side and at tip, black on outer surface for two-thirds their length. Femora and tibae yellow. Middle and hind femora each with one large preapical bristle, the latter ciliated on lower inner edge with long black hairs, the longest of which are longer than the width of the femora. Posterior tibiae slightly thickened, infuscated at tip on inner side for one-fourth their length and with a brown line on inner surface from near their base to the middle, sometimes almost uniting with the blackish color at tip, the glabrous stripe on upper surface broad and conspicuous, a little broken before the tip by a few little hairs. Fore and middle tarsi a little longer than their tibiae, darkened toward their tips. Fore tarsi with the last two joints black; first joint about as long as the following three taken together; fifth fully as long as the fourth, and with a point projecting over the claws, which terminates in several hairs, still the joint is scarcely compressed. Hind tarsi one and one-fourth times as long as their tibiae, wholly black. Calypters and halteres yellow, the former with black cilia.

Wings grayish; costa with a small knotlike enlargement at tip of first vein; last section of fourth vein bent before its middle, its tip widely separated from the tip of the third vein, which bends backward a little; hind margin of wing a little indented at tip of fifth vein, rather regularly rounded, the anal angle being rounded, but moderately prominent.

Female.—Face broad, grayish white; tarsi a little darker than in the male; hind tibiae less blackened at tip and without the brown line on inner surface which is found in the male; hind femora not ciliated; costa not enlarged at tip of first vein; otherwise about as in the male. Middle tibiae with three bristles below, two at apical third and one near basal third, their basitarsi without a bristle above.

Redescribed from the twotype specimens in J. M. Aldrich's collection, which were taken in Connecticut, and from 5 males and 5 females; 2 males and 3 females were taken at New Bedford, Massachusetts; 1 pair at Woods Hole, Massachusetts, July 2, 1899; 1 female at Ipswich, Massachusetts, July 29, 1909; and 2 males on Long Island, New York, July. [Chesapeake Beach, Maryland, at edge of salt water, September 8, 1920.—J. M. A.]

Types.—In the University of Kansas collection and in that of J. M. Aldrich.

No. 114. DOLICHOPUS REFLECTUS Aldrich.

Dolichopus reflectus Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 12.

Male.—Length 5 mm.; of wing 4.5-4.8 mm. Face moderately wide, slightly narrowed below, white. Front green with more or less blue or violet reflections. Antennae yellow; third joint darker or brownish, a little longer than wide, somewhat conical in outline, rather rounded at tip; palpi dark yellow. Lateral and inferior cilia yellow, about seven of the upper cilia on each side black.

Thorax green with bronze reflections, which usually form a median vitta on the dorsum, the anterior edge of which is dulled with grayish pollen, posterior portion and scutellum usually with blue reflections; pleurae dulled with white pollen. Abdomen green with bronze reflections, sometimes more bronze-brown with green reflections; the white pollen on its sides abundant and reaching upon the dorsum. Hypopygium black; its lamellae of moderate size, somewhat triangular in outline, but rounded at apex, whitish with a moderately wide black border on apical margin, which is jagged and bristly on its lower half, and fringed with delicate hairs on upper half.

Fore coxae yellow, their anterior surface covered with little black hairs. Middle and hind coxae black on outer side, yellow on inner surface and at tip. Femora and tibae yellow. Middle and hind femora each with one preapical bristle, the latter ciliated with long stiff black hairs on lower inner edge, these hairs inserted at nearly equal distances, but rather far apart, the longest hairs longer than the width of the femora. Posterior tibiae a little thickened, black at tip for one-fifth their length, their inner surface with a wide apparently glabrous stripe, which is narrowed apically, and is in reality covered with very minute black hairs. Fore and middle tarsi about one and a fourth times as long as their tibiae, infuscated from the tip of the first joint, which is about equal to the two following joints taken together, fourth and fifth joints of nearly equal length. Hind tarsi one and a third times as long as their tibiae, wholly black. Calypters and halteres vellow, the former with black cilia.

Wings (fig. 114) grayish; costa with a very slight enlargement at tip of first vein; last section of fourth vein sharply bent at nearly a right angle near its middle and with a stump of a vein at the posterior or first bend; hind margin of wing a little indented at tip of fifth vein; anal angle rather prominent but rounded.

Female.—Face wide, more grayish than in the male; third antennal joint about as long as wide; hind femora with a row of stiff black hairs on lower inner edge, the longest of which are about one-fifth as long as the width of the femora and might almost be called cilia; hind tibiae without the apparently glabrous stripe on inner surface; costa without an enlargement; otherwise about as in the male. Middle tibiae with three bristles below, one pair at apical third and one bristle at basal third, their basitarsi without a bristle above.

Redescribed from 1 female from the type material; it was taken at Philadelphia, Pennsylvania, May 30; also from 1 female from Lawrence, Kansas; 1 female and 2 males from Columbus, Ohio, May 10; 1 male taken at Buffalo, New York, June 24; 1 male at Boonton, New Jersey, June 2; 2 males at Lafayette, Indiana, June 4; 2 males at Algonquin, Illinois; 1 male taken at Jacksonville, Florida, by Mrs. Slosson; 1 male from Plummer's Island, Maryland, June 5, by W. V. Warner; and 2 males taken at Washington, District of Columbia, August 13, 1917, by A. L. Melander.

No. 115. DOLICHOPUS ALBICOXA Aldrich.

Dolichopus albicoxa Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 10, pl. 1, fig. 13.—Johnson, Insects of New Jersey, 1909, p. 756.

Male.—Length 4-4.5 mm.; of wing 4 mm. Face rather wide, sil-Front shining green. Antennae black; first joint yellow very white. on the lower edge; third joint scarcely longer than wide, obtusely pointed at tip. Lateral and inferior orbital cilia whitish. Palpi vellow.

Thorax dark shining green, sometimes with coppery reflections; these may form two narrow vittae along the center of the dorsum with a slender shining green line between them; the dorsum is distinctly dusted with white pollen. Abdomen shining green, sometimes with slight bronze reflections, and with spots of white pollen on the sides of the segments. Hypopygium black; its lamellae large, somewhat oval in outline, white with a rather narrow black border on the apical margin, which is jagged and bristly, upper edge fringed with black hairs, lower edge with a few pale ones.

Fore coxae pale yellow; their anterior surface covered with abundant silvery white pollen and appears bare, still they have numerous, very minute, white hairs, and the usual black bristles at tip. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter nearly bare below, their lower half having only very minute yellow hairs. Posterior tibia a little infuscated at tip, especially on inner side, where it is sometimes infuscated for one-third its length and in other specimens only a little, still always distinctly blackened on inner side. Fore tarsi (fig. 115a) nearly one and a half times as long as their tibiae; first joint about two-thirds as long as the tibiae; third and fourth each a little more than half as long as the joint preceding it; first three joints slender, yellow, last two black, compressed; fourth small, somewhat triangular, about as wide at apex as long; fifth wider than the fourth, somewhat oval in outline, about equal to the third in length, fringed with minute recumbent hairs on upper edge. Calypters, their cilia, and the halteres yellow.

Wings (fig. 115) grayish, more or less tinged with brown in front of third vein; costa scarcely at all enlarged at tip of first vein; last section of fourth vein a little bent before its middle; third vein bent backward a little so as to converge with fourth toward their tips; hind margin of wing a little indented at tip of fifth vein; anal angle nearly obsolete, the wing being narrowed at base.

Female.—Face wide, silvery white; third antennal joint nearly round with a notch above at tip, the arista inserted at upper corner of this notch; fore tarsi infuscated almost to their base, third and fifth joints of nearly equal length, fourth a little shorter, fifth a very little widened; middle tibiae with three bristles below, one pair at apical third and one bristle at basal third, their basitarsi with a large bristle above; in the male the middle tibiae have three bristles, as in the female, except that the one at basal third is small; in some females the basitarsi do not have the bristle above, but it may have been broken off; fore coxae less silvery than in the male and with conspicuous little black hairs on their anterior surface, except on the outer edge, where there are some very minute white ones; wings about as in the male, except that the anal angle is a little more promi-

nent. Cilia of calypters more or less blackish, usually the yellow predominating.

Redescribed from many males and females. The Aldrich collection contains specimens from New Hampshire, taken by Mrs. Slosson; Algonquin, Illinois, taken by Dr. W. A. Nason; Polk County, Wisconsin, July, taken by Baker; and Lafayette, Indiana, taken June 4-18, 1915, by J. M. Aldrich. I have taken it at Buffalo, New York, June 12, 1910; Gowanda, New York, June 15, 1913; Portage, New York, July 1, 1917; Ridgeway, Ontario, July 15, 1917; Fort Erie, Ontario, July 4, 1910; Chatham, Ontario, June 17, 1915; Bond Lake, Ontario, July 16, 1918. H. S. Parish took it at Waubamic, Ontario, June 14, 1915. A. L. Melander took it at Lynden, Vermont, June 13, 1914. In the United States National Museum are specimens taken at the White Mountains, New Hampshire, by Morrison; at Bristol, Rhode Island, June, 1878; and Beverly, Massachusetts, June.

Type localities. - Massachusetts and Connecticut. Aldrich reports it from Michigan. Johnson, Insects of New Jersey, 1909, reports it from Clementon, May 30: Anglesea, May 28: Burlington and Ocean Counties, May.

Type.—In University of Kansas. The females of albicoxa, variabilis, and socius differ as follows: Socius has no bristle on the middle basitarsi, which is usually, if not always, found in the others, and the posterior tibiae have sharply defined black tips; in variabilis these tibiae are wholly yellow, while in albicoxa they are blackened a little, especially on inner side, but the blackish color shades into the yellow. In albicoza the third and fourth veins of the wing are distinctly convergent, their tips being rather close together; in variabilis the tips are widely separated, but the third vein bends back a little at tip; while in socius the third and fourth veins are nearly parallel at tip, the third being nearly straight.

No. 116. DOLICHOPUS PILATUS, new species.

Male.—Length 5.7 mm.; of wing 5 mm. Face wide, grayish white. Front greenish, or bronze-brown with green reflections. Antennae (fig. 116) black; first joint yellow below; third moderately large, a little longer than wide, somewhat rounded at tip; arista, a little longer than the antennae with an enlarged, somewhat spear-shaped tip, which forms more than one third of its length. Lateral and inferior orbital cilia vellowish, about seven of the upper cilia on each side black.

Thorax greenish, or bronze-brown with green and coppery reflections; dorsum a little dulled with gray pollen; pleurae dulled with white pollen. Abdomen green with coppery reflections; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black; its lamellae rather large, somewhat elliptical in outline, but narrowed at base, about twice as long as wide, yellowish white with a broad black border on apical, and narrow border on upper margin, jagged and bristly at apex, fringed with black hairs above.

Fore coxae yellow, blackened at tip for nearly one half their length. their anterior surface covered with coarse black hairs. Femora and tibiae vellow. Middle and hind femora each with one preapical bristle, the latter ciliated on lower inner edge for one-third their . length with yellow hairs, the longest of which is a little shorter than the width of the femora. Posterior tibiae thickened, especially at tip, black at tip for more than one fourth their length; the glabrous stripe on upper edge distinct, their inner surface nearly glabrous on its basal two-thirds; on the lower outer edge there is a row of about six, regularly placed bristles of nearly equal length, which are about as long as the thickness of the tibia. Fore tarsi (fig. 116a) one and a third times as long as their tibiae; second joint about three-fourths as long as the first, third shorter than the second, fourth short, slightly compressed, about as long as wide; first three joints vellow. fourth yellow with brownish tip, fifth black, much compressed, not as long as third, somewhat triangular, about as wide near the tip as long. Middle tarsi black from the tip of the first joint, which has several small bristles on its sides and below, and one small bristle above. Middle tibiae with three large bristles on lower anterior surface and two on lower posterior edge, sometimes one of these seems to be missing. Hind tarsi wholly black. Calypters and halteres yellow, the former with yellow cilia which sometimes appear to be almost black in certain lights.

Wings grayish; costa with a slight elongated enlargement at tip of first vein; last section of fourth vein bent near basal third; third vein bent backward at tip, but the tips of third and fourth rather widely separated; hind margin of wing scarcely indented at tip of fifth vein; anal angle rather prominent but rounded.

Female.—Face a little wider than in the male; antennae as in the male except that the arista is plain, still it has a small but distinct thickening at its middle; fore tarsi plain, one and a third times as long as their tibiae, infuscated toward their tips, but only the fifth joint black, first joint as long as the three following taken together, fourth scarcely as long as fifth; hind femora without cilia below, their tibiae but little thickened, blackened a little at tip, not glabrous on inner surface, with the row of bristles on lower outer edge larger and less regularly inserted than in the male; middle basitarsi with a large bristle above; cilia of the calypteres black, still somewhat yellowish in certain lights; wings more tinged with brown; costa not thickened at tip of first vein.

Described from 2 males and 1 female taken at Nain, Labrador, August 18.

The formation of the fore tarsi and the costal enlargement are very much like that of splendidus Loew.

Type and allotype.—In the collection of the Boston Society of Natural History.

No. 117. DOLICHOPUS PORPHYROPS, new species.

Male.—Length, 4.5-5 mm.; of wing the same. Face moderately wide, silvery white, but slightly tinged with yellow. Front violet with a narrow edge of green in front and along the orbits. Antennae (fig. 117a) black; first joint with the lower half yellow; third joint large, nearly three times as long as wide, pointed at tip, arista inserted near apical third, longer than the antennae. Lateral and inferior orbital cilia whitish; about six of the upper cilia on each side black.

Thorax green, with three bright coppery vittae on the dorsum, the median one sharply defined, the lateral ones just above the pleural suture, wide and not so distinctly limited, extending from the front to the root of the wing; anterior portion of the dorsum somewhat dulled with brownish gray pollen; pleurae with silvery white pollen. Abdomen green with coppery reflections, which are more conspicuous on the hind margins of the segments; the white pollen on its sides abundant. Hypopygium black; its lamellae (fig. 117b) rather large, somewhat quadrilateral in outline, a little longer than wide, white, with a black border, which is wide on apical, narrow on upper margin, jagged and bristly at apex, fringed above with dark, below with pale hairs.

Fore coxae yellow, inner half of front surface with little black hairs, inner half with minute pale ones. Middle coxae black on the outersurface, with yellow tips. Hind coxae almost wholly yellow. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter nearly glabrous below. Posterior tibiae very little thicker than the others, blackened at tip, but the black shading into the yellow. Fore tarsi (nearly like fig. 116a) about one and a half times as long as their tibiae; first four joints yellow, fifth black; first three joints slender, fourth short, somewhat triangular, not much longer than the width of apical end; fifth joint much compressed and widened, somewhat triangular, nearly as wide at apex as long, truncate at tip, about three times as long as the fourth joint and about equal to the third in length. Middle tarsi longer than their tibiae, black from the tip of the first joint, which has a large bristle at apical fourth on upper surface. Hind tarsi wholly black. Calvoters and halteres vellow, the former with black cilia.

Wings (fig. 117) tinged with brownish; costa not enlarged at tip of first vein; last section of fourth vein rather sharply bent before its middle, sometimes with a little stump of a vein at the bend; hind margin of wing scarcely indented at tip of fifth vein, rather broadly rounded, the anal angle not being much developed.

Female.—Face wide; third antennal joint (fig. 117c) only a little longer than wide, oval, but a little pointed at tip; fore tarsi plain, first three joints yellow, last two black (sometimes only the first) and basal half of second joint is yellow, fifth joint slightly longer and broader than fourth; middle tibiae with three bristles below, one pair at apical third and one bristle at basal third, their basitarsi with a large bristle near apical third; wings about as in the male.

Described from many males and females from the following locations: Woods Hole, Massachusetts; Kiamesha, New York; Adirondack Mountains, Axton, New York, June 17; Lynden, Vermont, June 13, 1914, taken by A. L. Melander; Center Harbor, New Hampshire, June 25, taken by H. G. Dyar; and the following that were taken by C. W. Johnson: At Mount Washington, New Hampshire, July 16–28, 1915, at 2,000 feet elevation; Glen House, New Hampshire, July 20–26; Hanover, New Hampshire, July 6; Dummerston, Vermont, July 14, 1908; South West Harbor, Maine, July 13, 1908; and Machias, Maine, July 22, 1909.

Type.—Male, Cat. No. 23031, U.S.N.M., from Center Harbor, New Hampshire.

No. 118. DOLICHOPUS JUGALIS Tucker.

Dolichopus jugalis Tucker, Trans. Kansas Acad. of Sci., vol. 23, 1911, p. 160.

The following is a copy of the original description:

Colorado, Tabernash, 8,310 feet, western side of the continental divide of the Rocky Mountains, 89 miles west of Denver, August, 1906. Type: One male specimen.

General color shining green. Femora and other joints of the legs except as specified, yellow; cilia of inferior orbit pale; tegulae with black cilia, fourth vein deflected, running somewhat forward at tip.

Closely allied to coloradensis Aldrich, from which it differs in the following particulars: The first joint of the antennae is yellow only on the under side; face sub-opaque black, with comparatively coarse facets; front with a bronze reflection; thorax with a distinct median stripe of bronze. Fore coxae yellow, touched with black at base, and transversely marked on the front side with a preapical black line bordered by a row of fine black bristles, the two outer bristles are equally long, but inwardly the bristles are much reduced in size, and all are set behind the line. Fore tarsi two-thirds longer than their tibiae; first three joints extremely slender; the second scarcely longer than the first, the third less than two-thirds the length of the second, fourth and fifth together equal in length to the third, black and enlarged to all appearances the same as with coloradensis, unless more symmetrically equal on each side of the axial line. Lamellae of the hypopygium more than twice as long as wide, the tips touching posterior coxae. Costa of wing slightly thickened at junction of first vein. The posterior margin of scutellum is slightly tinged with yellow. In other respects, the tarsi of middle legs are strongly black from the tip of the first joint;

the posterior tibiae are infuscated at apex, their tarsi black; the middle and posterior tibiae bear two rows of long, stout, black bristles behind, and a few similar bristles are attached in front. On each of the middle and posterior femora a single bristle is situated at some distance before the apex. Fore coxae clothed with fine black hairs on the front surface in addition to the row of bristles. Palpi and halteres yellow. Length 5.5 mm.; wing 5 mm.

I have not seen the species.

Location of type not known. Hunter does not include it in his list of types in the University of Kansas, 1913.

No. 119. DOLICHOPUS PLUMITARSIS Fallen.

Dolichopus plumitarsis Fallen, Dolichopodes, 1823, p. 10.—Zetterstedt, Dipt. Scand., vol. 2, 1843, p. 556.—Schiner, Fauna Austr., vol. 1, p. 216.—Co-QUILLETT, Proc. Wash. Acad. Sci., vol. 2, 1900, p. 425.

Male.—Length 5 mm.; of wing 5.5 mm. Face rather narrow, silvery white. Front green with white pollen, antennae black; first ioint broadly yellow below; third joint one and a half times as long as wide, obtusely pointed at tip. Lateral and inferior orbital cilia white, about five of the upper cilia on each side black. Proboscis and palpi vellow.

Thorax green; dorsum with bronze reflections and a little gray pollen on the front portion; pleurae dulled with white pollen. Abdomen green; the white pollen on its sides not very abundant. Hypopygium black; its lamellae of moderate size, oval, white with a rather narrow black border, jagged and bristly on apical margin, fringed above with little black hairs.

Coxae, femora, and tibiae yellow. Middle and hind coxae largely blackened on outer surface; fore coxae wholly yellow, their anterior surface covered with minute yellow hairs. Middle and hind femora each with one prespical bristle, the hind ciliated with 8 or 10 long whitish hairs on the apical half of the lower inner edge, the longest hairs being as long as the width of the femora. Middle tibiae with three large bristles below, two near apical and one near basal third, their basitarsi with one large bristle above near apical third, and several small ones on the sides and lower surface. Posterior tibiae thickened, black at tip for one-fifth their length; the usual glabrous stripe on upper surface distinct, inner surface glabrous for their whole length on upper part, broadly except toward the tip. Fore tarsi (fig. 119) about one and three-fourths as long as their tibiae; first three joints yellow, last two black; second joint two-thirds as long as first, third three-fourths as long as second and a very little widened at tip; fourth and fifth compressed and fringed above with little black hairs, taken together about as long as second, fifth smaller and shorter than fourth, oval, fourth somewhat triangular, widest at tip. Middle tarsi one and one-fourth times as long as their tibiae, blackened from the tip of the first joint. Hind tarsi wholly black.

Calypters and halteres yellow, the former with black cilia, still they appear yellowish in certain lights.

Wings grayish; costa without an enlargement at tip of first vein; last section of fourth vein bent at its middle; third vein very nearly parallel with fourth beyond the bend in fourth and widely separated from it; hind margin of wing not indented at tip of fifth vein, evenly rounded, the anal angle not at all prominent.

Female.—Wings, coxae, and bristles of middle tibiae and basitarsi as in the male. Face wide, white; third antennal joint smaller; fore tarsi plain, a little longer than their tibiae, brownish from the base, but only the fifth joint black, second joint a little more than half as long as first, third a little shorter than second, fourth and fifth together as long as second, fourth a little longer than fifth; middle tarsi as long as their tibiae; hind femora without cilia below; posteria tibiae only a little thickened and a little blackened at tip, but they could not be said to be black at tip; calypteres with black cilia.

Redescribed from 1 male taken at Kukak Bay, Alaska, July 4, and 1 female from Europe.

Type.—In the University of Lund, Sweden.

No. 120. DOLICHOPUS POLLEX Osten Sacken.

Dolichopus pollex OSTEN SACKEN, Western Diptera, 1877, p. 314.

Male.—Length 4.7-6 mm.; of wing 4.2 mm. Face wide, a little narrowed below, silvery gray, tinged with yellow. Front reddish coppery, sometimes edged with green. Antennae wholly black, third joint but little longer than wide, obtusely pointed at tip. Lateral and inferior orbital cilia yellowish, about eight of the upper cilia on each side black.

Thorax green with reddish coppery reflections on the dorsum, sometimes mostly coppery, at others with three narrow coppery vittae; not very shining; pleurae dulled with white pollen. Abdomen green with coppery reflections, which are most conspicuous on the apical segments, somewhat dulled with white pollen. Hypopygium black; its lamellae rather large, nearly one and a half times as long as wide, oval, whitish, sometimes tinged with brownish yellow, with a black border on upper and apical margins, a little jagged and bristly on apical margin, especially at lower corner, fringed above with black hairs.

All coxae black; fore and middle pairs with yellow tips, their anterior surface covered with little black hairs. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter ciliated on lower inner edge with black hairs, the longest of which are nearly as long as the width of the femora. Posterior tibiae blackened at tip for more than one-fourth their length, a little thickened, their bristles large with about eight in a row; the glabrous stripe

between these bristles narrow, inner side glabrous on basal half and with a glabrous line inside of the inner row of bristles extending to their tips. Fore tarsi (fig. 120a) about one and a third times as long as their tibiae; first joint yellow with a black tip, a little less than half as long as the tibia; second and third joints whitish with black tips, the two taken together about three-fourths as long as the first; fourth black, compressed, as wide at tip as it is long, as long as third, fifth joint much compressed, black, divided into two lobes which are truncate at their tips, the lower lobe being the fifth joint and bearing at lower apical corner the small claws and white pulvilli, the upper lobe arising from the base of the lower and a little longer, wider at tip than in the middle. Middle tarsi one and a third times as long as their tibiae, black from the tip of the first joint, which has a large bristle above near apical third. Hind tarsi wholly black. Calypters and halteres vellow, the former with abundant black cilia.

Wings (fig. 120) dark gravish; costa with a small enlargement at tip of first vein; last section of fourth vein bent before its middle; hind margin of wing scarcely indented at tip of fifth vein; anal angle prominent, the wing being of somewhat equal width.

Female.—A female apparently belonging to this species has the face wider; the hind femora without cilia, hind tibise not glabrous on inner side, fore tarsi plain, longer than their tibiae, dark yellow, becoming infuscated from near the base, last three joints black. The middle basitarsi has the conspicuous bristle at apical third that is found in the male, their tibiae with three bristles below, one pair at apical third and one bristle near basal third.

Redescribed from 4 males and 1 female. Two males were taken at Cathedral Lake, Tahoe, California, July 6, by E. P. Van Duzee; 2 males taken in the Yosemite Valley, California, May 22, by E. T. Cresson, ir. The female was taken in Emigration Canyon, Utah, July 21.

Type locality.—Cathedral Lake, Sierra Nevada, California, July. Type.—In the collection of the California Academy of Sciences.

No. 121, DOLICHOPUS OBCORDATUS Aldrich.

Dolicho pus obcordatus Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 14, pl. 1, fig. 24.

Male.—Length 3.7-5.3 mm.; of wing 3-5 mm. Face wide, only a little narrowed below, covered with coarse ocher-yellow or yellowish grav pollen, often almost golden vellow. Front bronze or coppery with green margins, shining. Antennae wholly black; third joint rather large, longer than wide, somewhat conical in outline. Lateral and inferior orbital cilia yellowish, about six of the upper cilia on each side black.

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Thorax green with coppery reflections on the dorsum, which sometimes form a distinct median vitta; dorsum slightly dulled with an almost invisible gray pollen, more conspicuous along the front; pleurae dulled with a little white pollen. Abdomen green with bronze reflections; the white pollen on its sides extending upon the dorsum. Hypopygium black: its lamellae (fig. 121) of moderate size, oval, whitish, with a black border on apical and upper margins, a little jagged and bristly at apex, fringed above with short black hairs.

Coxae black with yellow tips; fore coxae with white pollen and little black hairs on their anterior surface. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter ciliated on lower inner edge for nearly their whole length with black hairs, which appear brown in certain lights, the longest of these hairs scarcely as long as the width of the femora. Posterior tibiae black at tip for nearly one-fourth their length, a little thickened; the glabrous stripe on upper surface distinct, inner surface glabrous on basal half and with a narrow glabrous line just inside of inner row of bristles on apical half. Fore tarsi (fig. 121a) about one and a half times as long as their tibiae, the first three joints yellow, slender, of decreasing length, the first being as long as the two following taken together; last two joints black, compressed, fourth about threefourths as long as third, not as wide at apex as long, fifth joint much widened, notched at apex, somewhat cordate, the lobes being of nearly equal size; a little longer than third joint and nearly as wide over the two lobes at tip as the length of the third joint. Middle tarsi about one and a third times as long as their tibiae, black from the tip of the first joint, which has a large bristle above near apical fourth. Hind tarsi wholly black, about one and a half times as long as their tibiae. Calvpters and halteres vellow, the former with black cilia.

Wings grayish; costa enlarged at tip of first vein, tapering to its tip; last section of fourth vein considerably bent before its middle, sometimes this bend bears a slight stump-vein; hind margin of wing scarcely indented at tip of fifth vein; anal angle prominent.

Female.—Face a little wider than in the male and more whitish; hind femora not ciliated; their tibiae not glabrous on inner surface; fore tarsi plain, as long as their tibiae, black from the tip of the first joint; middle tarsi a little longer than their tibiae, bristle on first joint placed at apical third; their tibiae with three bristles below, one pair at apical third and one bristle at basal third.

Redescribed from numerous males and females. Idaho, taken July to October (Aldrich); Utah, July; Colorado Springs, Colorado, June 9; Washington, May to July (Melander); Yellowstone Lake, Montana, July 9; Sheridan, Wyoming, June; Hood River, Oregon,

June to September (Cole); Tallac Lake, Tahoe, California, June 25; Nelson, British Columbia, July 17.

Type localities.—Wyoming and Manitou, Colorado.
Type.—In University of Kansas.

No. 122. DOLICHOPUS PERNIX Melander and Brues.

Dolichopus pernix MELANDER and BRUES, Biol. Bull., vol. 1, 1900, p. 141, fig.

Male.—Length 4.5-4.75 mm.; of wing 4-4.5 mm. Face moderately wide, narrower on lower half, white, more or less tinged with yellow, especially on upper portion. Front shining green. Antennae wholly black; first joint slightly brownish below; third joint longer than broad, oval, still rather pointed at tip. Palpi yellow with black hairs. Lateral and inferior orbital cilia yellowish, from five to eight of the upper cilia on each side black.

Thorax green with more or less bronze or coppery reflections; dorsum somewhat dulled with almost invisible gray pollen; pleurae dulled with white pollen. Abdomen green with coppery reflections near the hind margins of the segments, incisures narrowly black, the white pollen on its sides extending upon the dorsum so as to leave the central line blackish. Hypopygium black; its lamellae (fig 122a) of moderate size, somewhat elongate-oval in outline, still quite pointed at tip, twice as long as wide, yellowish white, narrowly brown at apex, with one or two long branched bristles at tip, fringed above with small brown hairs, below and on the disk with delicate vellow hairs.

Fore coxae yellow with a black spot at base on outer side, their anterior surface with little black hairs and a few minute yellow ones near outer edge. Outer surface of middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter nearly glabrous below. Posterior tibiae a little thickened, black at tip for nearly one-fifth their length, this black sharply defined; the usual glabrous stripe on upper surface although broad does not reach the base and is somewhat broken by a few little black hairs; (Melander and Brues in the original description write "hind tibiae not glabrous internally," but in all the specimens before me the upper half of the inner surface is glabrous, beginning near the base where it is wide and contains a brown streak in most specimens; probably the word "not" in the original description should have been omitted).

Fore tarsi (fig. 122b) one and a half times as long as their tibiae, first joint two-thirds as long as the tibiae, third joint only slightly shorter than the second, taken together they are a little longer than first; first three joints yellow; fourth and fifth black, a little compressed and expanded, of nearly equal length, the two taken together about as long as second. Middle tarsi one and a fourth times as long as their tibiae, infuscated from the tip of the first joint, still the base of second yellowish. Hind tarsi deep black, about one and a third times as long as their tibiae. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 122) grayish; costa scarcely enlarged at tip of first vein; last section of fourth vein bent at its second fifth; third vein bent backward at tip, still nearly parallel with fourth at extreme tip; hind margin of wing not indented at tip of fifth vein, slightly sinuated from tip of fifth to anal angle, which is prominent; wing of somewhat equal width.

Redescribed from 6 males in the collection of J. M. Aldrich, 1 taken at Keyport, Washington, August 7, 1905, the others at Seattle, Washington, and 2 males taken by A. L. Melander, in British Columbia, 1 at Abbotsford, August 9, and the other at Langley, August 9.

Type.—In American Museum of Natural History, New York, from Vancouver Island.

No. 123. DOLICHOPUS BLANDUS, new species.

Male.—Length 4.5-5.8 mm.; of wing 4-4.5 mm. Face moderately wide, narrower below, pale golden yellow. Front shining green, sometimes brassy green. First antennal joint wholly yellow or with a very narrow black line on upper edge, rather short; second and third joints black, taken together somewhat orbicular in outline, third rounded at tip; arista inserted near the base of the third joint, about twice as long as the antennae. Lateral and inferior orbital cilia pale yellow, about eight of the upper cilia black.

Thorax green with brassy reflections, dulled with gray pollen along the front edge of the dorsum; pleurae dulled with white pollen. Abdomen green with coppery reflections and narrow black incisures; the white pollen on its sides extends upon the dorsum. Hypopygium black; its lamellae (fig. 123a) large, twice as long as wide, somewhat oval in outline but narrowing into the stem, whitish, with the apical margin broadly, and the upper narrowly black, jagged and bristly on lower apical corner, otherwise the apical and upper edges are fringed with rather short brown hairs; lower edge with a few pale hairs.

Fore coxae yellow with a black spot at base on outer side, anterior surface with little black hairs; middle and hind coxae black with narrow yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter without cilia below, the little black hairs on the sides reaching the lower edge. Posterior tibiae scarcely thickened, their apical half black, shading into the yellow, sometimes the yellow extends farther toward the tip on the lower edge; the glabrous stripe on upper edge distinct and reaching from near the base to their tips. Fore tarsi (fig. 123b) one and a half

times as long as their tibiae; three first joints slender, yellow, sometimes the extreme tip of third blackened, second nearly three-fourths, third one-third as long as first; fourth and fifth joints black, compressed, fourth half as long as third, as wide as long, fifth much widened, as long as second, somewhat oval but narrowed toward the base and straight below, near the apex a little less than half as wide as long. Middle tarsi a little longer than their tibiae, black from the tip of the first joint, which has a bristle above. Hind tarsi one and a fourth times as long as their tibiae, wholly black. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 123) gravish, sometimes a little tinged with brown in front of third vein; costa a little thickened at tip of first vein, tapering from there to its tip; last section of fourth vein a little before its middle, its tip far before the apex of the wing; hind margin of wing scarcely indented at tip of fifth vein; wing of rather equal width, the anal angle being prominent.

Female.—Differs from the male in having the face broad with vellowish gray pollen; the fore tarsi are plain, a little longer than their tibiae, black from the tip of the first joint, which is about as long as the three following joints taken together; hind tibiae less blackened at tip; the wings are a little more tinged with brown; the costa is scarcely at all thicker at tip of first vein; posterior margin of wing a little more broadly rounded, the anal angle being a little less prominent.

Described from 5 males and 1 female. One male was taken at Emigration Canyon, Utah, July 27, 1917, and 1 pair at Tennessee Pass, Colorado, July 25, 1917, by J. M. Aldrich; 1 pair was taken by Baker in Colorado; 1 pair at Beaver Creek, Montana, in Aug., 1913, by S. J. Hunter, at an elevation of 6,300 feet; 1 male was taken by W. M. Mann, at Nigger Hill, Powell County, Montana, in July.

Tupe.—Male, Cat. No. 23032, U.S.N.M., from Tennessee Pass, Colorado. No. 124. DOLICHOPUS VIGILANS Aldrich.

Dolichopus vigilans Aldrich, Kansas Univ. Quart., vol. 2, p. 13, pl. 1 fig. 18.

Male.—Length 5.2-5.5 mm.; of wing 4.1-4.5 mm. Face rather wide, silvery white, tinged with yellow on upper half or more. Front violet with a narrow border of green above the antennae and along the orbits. Antennae yellow with the apical half of third joint black; third joint conical, about as long as wide; arista twice as long as the antennae. Proboscis black; palpi yellow. Lateral and inferior orbital cilia whitish, about six of the upper cilia on each side black.

Thorax green, scutellum and sometimes the dorsum with blue reflections, usually there is a coppery spot on the sides at the suture; anterior part of the dorsum a little dulled with gravish pollen which

becomes more yellowish on the disk; pleurae dulled with white pollen. Abdomen green with the hind margins of the segments narrowly black and with bronze reflections; the white pollen on its sides forms large spots on each segment and extends upon the dorsum. Hypopygium black with green reflections; its lamellae moderately large, somewhat round in outline, but with the lower edge straight and the lower outer corner rather angulated, jagged and bristly, elsewhere the upper and outer margins are fringed with short black hairs and are narrowly black, the disk being white.

Fore coxae yellow, sometimes with a brown spot at base on outer side, anterior surface with conspicuous black hairs on inner half. Middle and hind coxae black on outer side, vellow on inner surface and at tip, the posterior ones sometimes mostly yellow. Femora and tibiae vellow. Middle and hind femora each with one bristle before the tip, the latter with yellow cilia on apical third of lower inner edge, the hairs being about one third as long as the width of the femora. Posterior tibiae thickened; their tips narrowly black; the glabrous stripe on upper surface distinct and extending from near the base to apical fourth where it is broken by a row of hairs; inside of the inner row of large bristles is a glabrous stripe extending their entire length but widest near the base. Fore tarsi (fig. 124a) about one and a half times as long as their tibiae; first two joints slender, yellow, second fully half as long as first, third about two-thirds as long as second, its apical half infuscated and a little widened; fourth and fifth joints black, compressed, fourth fully half as long as third, about as wide as long, fifth nearly as long as second, straight below, widened apically, the widest point at the claws, the upper corner extending beyond the claws, rather acute at tip; pulvilli white. Middle tarsi one and a fourth times as long as their tibiae, darkened from the tip of the first joint, the joints paler at base, tip black, basitarsi with a large bristle above at apical third. Hind tarsi wholly black, one and a half times as long as their tibiae. Calvoters and halteres vellow, the former with black cilia.

Wings (fig. 124) grayish; costa with a slight knot-like enlargement at tip of first vein; last section of fourth vein bent before its middle; hind margin of wing a little indented at tip of fifth vein; anal angle prominent, the wing being of somewhat equal width; hind margin a little sinuated.

Female.—Differs from the male in having the face wide with grayish pollen; fore tarsi plain, a little longer than their tibiae, infuscated from the tip of the first joint; middle tibiae with three bristles below, one pair at apical third and one bristle at basal third; hind femora without cilia below; hind tibiae less thickened and without the glabrous stripe on inner surface; costa not enlarged at tip of first vein; wing a very little wider.

Redescribed from many specimens from the following localities: Toledo, Ohio; Lafayette, Indiana, June 20-July 4; Erie County, New York, June 18-August 8; Niagara County, New York, August 4; Fort Erie, Ontario, June 20-July 13; Black Creek, Ontario, July 24; Niagara Falls, Ontario, July 31.

Type locality.—Douglas County, Kansas, June 24. Type.—In the collection of the University of Kansas.

No. 125. DOLICHOPUS FLAGELLITENENS Wheeler.

Dolichopus flagellitenens Wheeler, Psyche, vol. 5, 1890, p. 339.—Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 13, pl. 1, fig. 11.-MELANDER and BRUES, Biol. Bull., vol. 1, 1900, p. 148.

Male.—Length 4.5-5.5 mm.; of wing 4.2-4.75 mm. Face moder ately wide, pale golden yellow, sometimes more yellowish white Front green, often with bronze reflections. First antennal join! yellow; second yellow on lower half, black above, sometimes only the upper edge black; third joint black, somewhat oval, a little longer than wide. Proboscis black; palpi yellow. Lateral and inferior orbital cilia yellow, about eight of the upper cilia on each side black.

Thorax green, sometimes with coppery reflections, which often form a median vitta on the dorsum, the front and central portion of which has rather thick gray pollen; pleurae dulled with white pollen. Abdomen green with coppery reflections; the white pollen on its sides forming spots on the lower edges of the segments. Hypopygium black; lamellae (fig. 125a) rather large, somewhat oval in outline, twice as long as wide, whitish with rather wide apical and narrow upper border of black, jagged and bristly at apex, fringed above with little black hairs and below with a few delicate yellow

Fore coxae yellow, with the extreme base a little blackened, their anterior surface covered with black hairs. Middle and hind coxae black, with broad yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter without cilia below, but with the black hairs on the sides reaching the lower edge. Posterior tibiae thickened, their apical half black, still the vellow often extends to the tip on the lower surface; the glabrous stripe on upper surface distinct and reaches their entire length but is a little broken by a few hairs. Middle tibiae with four bristles on lower surface, one pair near apical third and two at equal distances toward their base. Fore tarsi (fig. 125b) nearly one and a third times as long as their tibiae, the first four joints taken together about equal to the tibia in length; second joint half as long as first and a little more slender; first three and most of fourth yellow, sometimes mostly black; third and fourth taken together but little more than half as long as second, fourth slightly shorter than third, as wide as long; fifth joint black, much compressed and widened, scarcely as long as the first but longer than the second, not quite as wide as long, somewhat oval in outline, fringed above with little black hairs; the white pulvilli quite conspicuous. Middle tarsi one and a fourth times as long as their tibiae, black from the tip of the first joint, which has a large bristle on upper surface and a smaller one on the anterior upper edge. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 125) grayish, sometimes a little tinged with brown in front or along the veins; costa slightly enlarged at tip of first vein; last section of fourth vein a little bent beyond its basal third; third vein bent a little backward at tip; hind margin of wing a little instead at tip of fifth vein; wing rather narrow and of nearly equal thirdth, the anal angle being prominent.

* Female.—Face wide, grayish white; fore tarsi plain; usually with only the last joint black, fifth joint nearly twice as long as fourth, first longer than the three following joints taken together; hind tibiae scarcely at all thickened, its apical fifth black, but this black shading into the yellow, so they are sometimes infuscated almost from their middle; otherwise about as in the male.

Redescribed from several males and females from the following locations: Polk County, Wisconsin, July, taken by Baker; Brookings, South Dakota, June 16, taken by J. M. Aldrich; White Mountains, New Hampshire, taken by Morrison; Ottawa, Canada, July; I have taken it at East Aurora, New York, June 2, and at Ridgway, Ontario, July 15.

Type locality.—Milwaukee County, Wisconsin; Aldrich reports it from South Dakota and Colorado; Melander and Brues from Illinois.

No. 126. DOLICHOPUS BIFRACTUS Loew.

Dolichopus bifractus Loew, Neue Beitr., vol. 8, 1861, p. 19; Mon. N. Amer. Dipt., pt. 2, 1864, p. 53.—Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 12, pl. 1, fig. 14; Biologia Centrali-Americana, Dipt., vol. 1, 1901, p. 333.—Johnson, Insects of New Jersey, 1909, p. 757.

Male.—Length 4-5.5 mm.; of wing 4-5 mm. Face wide, white to yellowish gray, being quite variable in color. Front green, covered with yellowish gray pollen which often conceals the ground color. Antennae yellow; third joint brown at tip, longer than wide, conical, with a distinct swelling at the insertion of the arista, which is black. Lateral and inferior orbital cilia yellowish, about six of the upper cilia on each side black.

Thorax green with bronze reflections; dorsum covered with yellowish brown pollen with often conceals the ground color; pleurae with abundant white pollen. Abdomen green with bronze reflections; the pollen on its sides more gray than in most species and extending upon the dorsum. Hypopygium black; its lamellae of moderate

size, somewhat triangular in outline, with the outer part rounded, whitish with a narrow black border on apical margin, jagged and bristly on the lower half of the rounded apical margin, upper half with delicate brown hairs, fringed on the lower edge, which is nearly straight, with a few delicate little pale hairs.

Fore coxae yellow, with little black hairs on inner half of anterior surface; these hairs sometimes cover the whole of the apical half and do not always reach the base of the coxae; middle coxae blackish on outer surface except at tip; hind coxae usually wholly yellow, sometimes a little blackened on outer surface. Femora and tibiae vellow. Middle and hind femora each with one preapical bristle. the latter nearly glabrous below, except for a row of minute vellow hairs on lower inner edge. Posterior tibiae slightly thickened, blackened a little at tip, but sometimes only slightly so. Fore tarsi (fig. 126a) one and a fourth times as long as their tibiae, first three joints dark yellow, fourth and fifth black, a little compressed, upper edge of fifth fringed with stiff black hairs, fourth nearly as wide at tip as long, about half as long as fifth; first joint about as long as the three following taken together. Middle tarsi about one and a third times as long as their tibiae, black from the tip of the first joint, still the base of the second joint often vellowish, their basitarsi with a bristle above; middle tibiae with three bristles below, one pair at apical third and one bristle at basal third. Hind tarsi wholly black. one and a third times as long as their tibiae. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 126) grayish, usually slightly brownish along the veins and sometimes in front; costa not thickened at tip of first vein; last section of fourth vein bent at right angles before its middle and with a stump of a vein; frequently the upper bend is also a right angle and may even have a stump; hind margin of wing a little indented at tip of fifth vein; anal angle prominent.

Female.—Face a little wider than in the male, antennae nearly wholly yellow; fore tarsi colored about as in the male, but the fourth and fifth joints are not compressed; otherwise about as in the male.

Redescribed from numerous males and females from the following locations: Custer, South Dakota; Brookings, South Dakota, June 12 (Aldrich); Lawrence and Baldwin, Kansas; Riley County, Kansas, Sept.; Lafayette, Indiana, June 6-Oct. 13; Fargo, North Dakota; Ohio; Woods Hole, Massachusetts; Hanover, New Hampshire; Ames, Iowa; western New York, June 13-Oct. 6; Chicago, Illinois; Fort Erie, Ridgeway, Toronto, Kearney, and Sudbury, Ontario, June 22-Aug. 8; Montreal, Quebec, June 15.

Type localities.—Chicago, Illinois, and Nebraska. Aldrich (in Biologia Cent. Amer.) reports it from Cuernavaca, Mexico, much farther south than any other true Dolichopus has been found; John-

son, Insects of New Jersey, reports it from Jamesburg, July 4, and Westville, Aug. 18.

No. 127. DOLICHOPUS PUGIL Loew.

Dolichopus pugil Loew, Centuries, vol. 8, No. 77.—Johnson, Insects of New Jersey, 1909, p. 756.

Dolichopus henshawi WHEELER, Psyche, vol. 5, 1890, p. 340.—MELANDER and BRUES, Biol. Bull., vol. 1, 1900, p. 134.

Male.—Length 5-6 mm.; of wing 4.75-5 mm. Face moderately narrow, long, yellow. Front violet with a narrow edge of green along the orbits and above the antennae. Antennae yellow; first joint rather long, with bristly hairs on upper half; third joint a little longer than wide, somewhat conical in outline, pointed at tip, its apical half black; arista thick, longer than the antennae. Proboscis black; palpi yellow. Lateral and inferior orbital cilia yellow, ending in one black bristle at the proboscis, about six of the upper cilia on each side black.

Thorax green with coppery reflections, which usually form a median vitta on the dorsum, it often has blue reflections on the posterior portion and on the scutellum; a little dulled with grayish pollen along the front of the dorsum and with brownish pollen on the disk which is easily overlooked; pleurae dulled with white pollen. Abdomen green with green reflections; the white pollen on its sides extends upon the dorsum. Hypopygium black; its lamellae rather large, somewhat round in outline but narrowing into the stem, whitish with a narrow black border on the apical margin, jagged and bristly at lower corner, the rest of the apical margin fringed with long black bristly hairs, which are nearly as long as the width of the lamellae, lower edge with a few yellow hairs.

Fore coxae yellow, usually with a blackish spot at base on outer side, their anterior surface covered with conspicuous black hairs; middle and hind coxae black with vellow tips. Femora and tibiae vellow. Middle and hind femora each with one preapical bristle, the latter ciliated on lower inner edge with long black hairs, the longest of which are nearly one and a fourth times as long as the width of the femora, on basal fourth the hair become short and vellowish. Anterior tibiae (fig. 127a) a little enlarged and slightly infuscated at tip, where there are a few conspicuous flattened black. hairs. Posterior tibiae a little thickened, blackened a little at tip on lower surface and on the sides, yellow to the tip on upper surface; on inner side there is a blackish streak extending toward the base from the black of the tip and also a blackish streak from the base to the middle, sometimes it reaches the tip. Fore tarsi (fig. 127b) one and a fourth times as long as their tibiae; first joint pale vellow with a black tip, nearly as long as the three following joints taken together; second and third of nearly equal length, wholly pale yellow; fourth about one-half as long and a little wider than third, pale

yellow with the tip black; fifth joint as long as third, black, compressed and widened, nearly oval. Middle tarsi nearly as long as their tibiae, yellow with the tips of the first three joints and the whole of the last two black. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 127) broad, grayish, sometimes the veins are very slightly bordered with brownish; costa with a small knot-like enlargement at tip of first vein; last section of fourth vein moderately bent a little before its middle; hind margin of wing a little indented at tip of fifth vein; anal angle prominent.

Female.—Face wide, gravish white; antennae about as in the male, but sometimes the first joint is black on upper edge of outer side; fore tarsi a little longer than their tibiae, yellow, becoming darker toward their tip, but only the last joint black, first four joints slightly darker at their tips, basitarsi nearly as long as the three following joints taken together, fourth joint two-thirds and fifth nearly as long as third; middle tarsi as in the male, except that the yellow at base of second and third joints is less conspicuous; hind tibiae only slightly brownish at tip and without the brown streaks on inner surface; hind margin of wing a little more evenly rounded than in the male, the anal angle being more rounded and the wing wider between the fifth and sixth veins.

Redescribed from 10 males and 2 females taken as follows: Woods Hole, Massachusetts; Horse Neck, Beach, Massachusetts (Hough); Cohasset, Massachusetts, July 22-September 8; Machias, Maine, July 17; Buffalo, New York, June 27.

Type locality.—Canada. Type locality for henshawi Wheeler is Massachusetts. Johnson, Insects of New Jersey, reports it from Cape May, June 23.

Type.—In Museum of Comparative Zoology, Cambridge, Massachusetts.

No. 128. DOLICHOPUS PLUMIPES Scopoli.

Musca plumipes Scopoli, Entomologia Carniolica, 1763, p. 334.

Dolichopus pennitarsis Fallen, Dolichopodes, 1823, p. 6.—Stannius, Isis, 1831, p. 63.—ZETTERSTEDT, Dipt. Scand., vol. 2, p. 541, 1843.

Dolichopus plumipes LOEW, Mon. N. A. Dipt., vol. 2, 1864, p. 60.—Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 13.—Coquillerr, Proc. Wash. Acad. Sci., vol. 2, 1900, p. 423.—LUNDBECK, Diptera Danica, vol. 4, 1913, p. 99.

Hygroceleuthus plumipes MELANDER and BRUES, Biol. Bull., vol. 1, 1900, p. 127,

Male.—Length, 3.5-4.5 mm.; of wing 3.5-4 mm. Face rather narrow, long, reaching nearly to the lower corner of the eyes, pale yellow to other yellow. Front shining green. First two joints of the antennae yellow, third black, usually more or less yellow at base, nearly twice as long as wide, ovate but a little pointed at tip. Palpi yellow. Lateral and inferior orbital cilia yellow, a few of the upper cilia black.

Thorax green, sometimes with coppery or bronze reflections; pleurae dulled with white pollen. Abdomen green with white pollen on its sides. Hypopygium black with green reflections; its lamellae rather small, somewhat oval in outline, whitish, sometimes almost brown, with a narrow black margin, which is broadest at the apex and extends along both edges in some specimens, in others only along the upper edge, jagged and bristly on apical margin, especially at the lower corner, fringed above with little brown hairs.

Fore coxae yellow with little black hairs on the anterior surface. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter without cilia below. Middle tibiae a little longer than their femora, compressed, very slender except at base and tip, where they are nearly normal in size, usually with a blackish line on upper edge and when viewed from the side there often appears to be a median brown line extending nearly their whole length; their anterior side is covered with silvery pollen, and near the tip is a whitish ring, which sometimes only shows as a whitish spot on the front surface; extreme tips black. Posterior tibiae a little thickened, black at tip for a short distance; inside of the inner row of large bristles is a slender glabrous line extending nearly their whole length. Fore tarsi about one and a fourth times as long as their tibiae, infuscated from the tip of the first joint, which is about as long as the three following joints taken together. Middle tarsi (fig. 128a) black, about three fourths as long as their tibiae, the first joint about as long as the two following joints taken together, a little thickened, fringed on both sides with black hairs which give it a broad, somewhat elongate-oval form. Hind tarsi wholly black, a little longer than their tibiae. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 128) grayish, sometimes tinged with brown; costa with a small knottike enlargment at tip of first vein; last section of fourth vein bent before its middle; hind margin of wing scarcely indented at tip of fifth vein, beyond which is a slight sinus that leaves a broad lobe at tip of sixth vein, the anal angle being very prominent.

Female.—Face wider, shorter and more gray than in the male; middle tibiae normal, their tips slightly enlarged, sometimes more conspicuously black than in the male, at others nearly yellow; middle tarsi normal, wholly black, about as long as their tibiae, first joint without a bristle above, their tibiae with one large bristle below;

costa scarcely enlarged at tip of first vein; hind margin of wing nearly straight; anal angle prominent.

Redescribed from many males and females from the following localities: Europe; Yakutat, Alaska, June 21 (Kincaid); Moscow, Idaho, June 14 (Aldrich); Sheridan, Wyoming, July (Metz); Monterey, California, July 13 (Wheeler); Washington several places, May 29-July 24; Yellowstone Park, North West Entrance, August 4; Colorado; Wells, Nevada, June 6; Erwin, South Dakota, June; Eastport, Maine, June 29.

Loew reports it from Quebec, Canada; Aldrich, South Dakota and Colorado; Melander and Brues from Colorado and Vancouver Island; Skinner from Beulah, New Mexico; Coquillett from Alaska, several places.

Location of type unknown; described from Europe.

No. 129. DOLICHOPUS DASYPODUS Coquillett.

Dolichopus dasy podus Coquillett, Canadian Entomologist, vol. 42, p. 42.

Male.—Length, 4 mm.; of wing, the same. Front moderately wide, pale yellowish. Front green, somewhat dulled with gray pollen: first antennal joint wholly yellow or with the upper edge very narrowly black; second and third joints black, taken together somewhat oval in outline, a little longer than wide; third obtusely pointed at tip. Lateral and inferior orbital cilia pale yellow, more white below, the black cilia descending about one-fourth the eye height.

Thorax green with bronze reflections, forming the beginnings of two narrow vittae on the front of the dorsum, which is dulled with white pollen, especially in front; pleurae dulled with white pollen. Abdomen green with slight bronze reflections and narrow black incisures; the white pollen on its sides conspicuous. Hypopygium black; its lamellae of moderate size, somewhat quadrangular in outline, whitish or yellowish with rather wide black border on apical and upper margins; jagged and bristly at apex, fringed above with stiff black hairs.

Fore coxae wholly yellow with silvery pollen and minute pale hairs on anterior surface. Middle and hind coxae black with yellow tips. Femora and tibiae yellow; middle and hind femora each with one préapical bristle, the latter nearly bare below. Middle tibiae slightly enlarged at tip and with a somewhat opalescent, elongated spot at tip on upper surface; posterior pair with a brown or blackish spot on outer and inner side at tip; the glabrous stripe on upper surface conspicuous and extending their whole length. Fore tarsi one and a fourth times as long as their tibiae, black from the extreme tip of the first joint, their joints of regularly decreasing length. Middle tarsi only a little longer than their tibiae, wholly deep black, their basitarsi thickened about as those of the hind tarsi and with several bristles, two of the upper ones large. Hind tarsi wholly black, a little longer than the middle pair. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 129) grayish, slightly darker in front of the third vein; costa not enlarged at tip of first vein; last section of fourth vein bent a little beyond its basal third; hind margin of wing scarcely indented at tip of fifth vein; anal angle of wing very prominent, with a small lobe extending toward the base of the wing and making the wing of somewhat equal width; there is a shallow sinus between the tips of fifth and sixth veins.

Female.—First antennal joint yellow with the upper edge black; middle tarsi wholly deep black, contrasting strongly with the wholly yellow tibiae, their first joint not much thickened and with a single bristle above, middle tibiae with one long bristle below, without the opalescent spot at tip on upper surface; face wide, yellowish white; wings with the anal angle prominent as in the male, but without the sinus between the tips of the fifth and sixth veins; they are a little wider and more rounded on the hind margin than they are in the male.

Redescribed from the single male type specimen in the National Museum, which was taken by Mrs. Slosson at Mount Washington, New Hampshire; several males and 2 females taken at Hopedale and Caribou Island, Labrador, by Packard; and 1 female taken in the White Mountains, New Hampshire.

The female standing with the type in the United States National Museum collection is probably another species. A female taken at Fort Wrangle, Alaska, with the middle tarsi wholly black has the tips of the middle tibiae blackened, and the first and most of the second antennal joints yellow; the middle tibiae have the single long bristle below, but their basitarsi have no bristle above; it no doubt belongs to still another species.

Type.—Male, Cat. No. 12766, U.S.N.M.

No. 130. DOLICHOPUS UXORCULA, new species.

Female.—Length 4.5 mm.; of wing 4 mm. Face wide, grayish or yellowish gray; front green with bronze or blue reflections. Antennae yellow with the apical half of third joint blackish; third joint a little longer than wide, pointed at tip. Lateral and inferior orbital cilia yellowish, about eight of the upper cilia on each side black.

Thorax green, sometimes with bronze reflections; dorsum dulled with grayish or brownish pollen; pleurae dulled with white pollen. Abdomen green with bronze reflections and a little white pollen on its sides.

Fore coxae yellow with conspicuous little black hairs on their anterior surface; middle and hind coxae black with their tips narrowly

yellow. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle. Posterior tibiae a little blackened at tip, middle tibiae also a little darkened at extreme tips, with one long bristle below. Fore tarsi one and a fourth times as long as their tibiae, black or brownish from their base, first joint as long as the three following taken together, fifth longer than the fourth; middle tarsi a little longer than their tibiae, wholly deep black, first joint but little thickened, without a bristle above, about as long as the two following joints taken together. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 217) grayish, a little clouded along the cross-vein and the last section of fourth vein; last section of fourth vein bent before its middle; anal angle prominent.

Described from 3 females: 1 taken at Fort Wrangle, Alaska, by Wickham; 1 taken at Helena, Montana, August 9, 1901, by A. L. Melander; and 1 at Huntington Lake, Fresno County, California, July 27, 1919, at 7,000 feet elevation, by E. P. Van Duzee, and in the California Academy of Sciences.

Type.—Male, Cat. No. 23033, U.S.N.M., from Fort Wrangle, Alaska.

No. 131, DOLICHOPUS FULVIPES Loew.

Dolichopus fulvipes LOEW, Cent., vol. 2, 1861, No. 61; Mon. N. Amer. Dipt., pt. 2, 1864, p. 61.

Male.—Length 4.75-5.75 mm.; of wing the same. Face moderately wide, long, reaching nearly to the lower corner of the eyes, rounded below, golden yellow. Front dark shining green, often blue, almost violet. First antennal joint (fig. 131a) yellow, rather long, the hairs on upper surface numerous and stiff; second joint yellow; third joint yellow with apical half blackish, twice as long as wide, somewhat elliptical, obtusely pointed at tip, arista inserted at the middle of the upper edge, as long as the antennae. Lateral and inferior orbital cilia yellow, about six of the upper cilia on each side black. Proboscis blackish; palpi yellow.

Thorax green with bronze and blue reflections, usually with a narrow bronze line on each side of the acrostichal bristles; dorsum a little dulled with gray pollen; pleurae dulled with white pollen. Abdomen green with bronze reflections; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black, its lamellae rather small, somewhat oval in outline, about one and a half times as long as wide, whitish with a very narrow black border on the apical margin, which is jagged and bristly, fringed above with delicate brown hairs.

Fore coxae yellow, their anterior surface with black hairs, there are a few minute yellow ones on outer edge of front side. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle

and hind femora each with one preapical bristle, the latter without cilia below, but with minute yellow hairs on lower inner edge. Middle tibiae distinctly swollen at tip on the front side, this swollen part glabrous, shining and whitish opalescent. Hind tibiae a little infuscated at tip on inner side; there are about six large bristles in each row on upper surface, the glabrous stripe between these rows is broken by a few little hairs, inside of the inner row is another glabrous line. Fore and middle tarsi about as long as their tibiae, infuscated from the tip of the first joint, still the base of the second and third joints are often yellow; first joint nearly as long as the three following joints taken together; fourth and fifth of nearly equal length. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 131) grayish, sometimes a little tinged with yellowish in front; costa scarcely enlarged at tip of first vein; last section of fourth vein a little bent before its middle; hind margin of wing scarcely indented at tip of fifth vein, but with a deep, wide sinus between the tips of fifth and sixth veins, the hind margin being nearly parallel with the fifth vein for some distance, and forming a large lobe at tip of sixth vein which includes the prominent anal angle.

Female.—Face wide, grayish white; antennae as in the male but shorter; middle tibiae normal at tip, and with one large bristle below, their basitersi without a bristle above; wings (fig. 131b) normal, the hind margin rather evenly rounded, the anal angle not very prominent, rounded.

Redescribed from 12 males and 5 females. One male was taken at Franconia, New Hampshire, and 1 female taken at Machias, Maine, July 26, by C. W. Johnson; I have taken 10 males and 2 females in Erie County, New York, May 31-July 4, and 1 female at Kearney, Ontario, July 3; H. S. Parish took 1 pair at Waubamic, Ontario, June 14.

Type locality.—Illinois.

Type.—In Museum of Comparative Zoology, Cambridge, Massachusetts.

No. 132. DOLICHOPUS FLAVICOXA, new species.

Male.—Length 3.75–4.25 mm.; of wing 5 mm. Face quite wide, its sides nearly parallel, silvery white. Front violet, more green along the orbits. First antennal joint yellow, the upper edge sometimes black or the upper half may be infuscated, but scarcely black; second and third joints black, the latter but little longer than wide, rounded at tip. Lateral and inferior orbital cilia whitish, about six of the upper cilia on each side black.

Thorax green with bronze reflections; in one specimen the posterior portion of the dorsum and the scutellum are mostly violet; dorsum dulled with gray pollen; pleurae with white pollen. Abdomen green

with coppery reflections; the white pollen on its sides rather thin. Hypopygium black; its lamellae (fig. 132a) small, oval, whitish with a narrow black border on apical margin, which is jagged and bristly, fringed above with brown, below with a few pale hairs.

Coxae vellow, middle pair a little brownish on outer side; fore coxae with minute, delicate, yellowish hairs on the anterior surface. Femora and tibiae yellow. Middle femora with one stout and one slender preapical bristle; hind femora with one rather long curved preapical bristle, ciliated below with a few long whitish hairs, the longest of which are as long as the width of the femora. Posterior tibiae a little brownish at tip, but little thicker than the others. Fore tarsi one and a fourth times as long as their tibiae, black from the tip of the first joint, which is as long as the three following joints taken together, fourth joint a little longer that the fifth. Middle tarsi a little longer than their tibiae, black from the tip of the first joint, which has a large bristle above; middle tibiae with three bristles below, two near apical third and one near basal third. Hind tarsi wholly black. Calvpters and halteres vellow, the former with black cilia.

Wings (fig. 132) tinged with brownish gray; costa with a rather small knot-like enlargement at tip of first vein; last section of fourth vein a little bent at basal third; hind margin of wing scarcely indented at tip of fifth vein, rather evenly rounded, the anal angle not being prominent: the wing widest just basally from the tip of fifth vein. narrowing from that point to the root of the wing.

Female.—Agrees with the male in the color of the front, thorax, abdomen, legs, feet, and wings, also in having pale hairs on the fore coxae, and in the form of the wing, except that the costa is not enlarged at tip of fifth vein and the wing is perhaps a little broader. It differs in having the face wide, grayish white; the fore tarsi shorter, being about as long as their tibiae; and the hind femora without cilia below; the middle and hind femora each have one preapical The bristles on middle tibiae and basitarsi are as in the bristle. male.

Described from 2 males and 2 females, taken in Polk County, Wisconsin, in July, by C. F. Baker, and given by him to J. M. Aldrich.

Type.—Male, Cat. No. 23034, U.S.N.M.

No. 133. DOLICHOPUS VARIABILIS Loew.

Dolichopus variabilis Loew, Neue Beitr., vol. 8, 1861, p. 17; Mon. N. Amer. Dipt., pt. 2, 1864, p. 50.—Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 11.— MELANDER and BRUES, Biol. Bull., vol. 1, 1900, p. 148.—JOHNSON, Insects of New Jersey, 1909, p. 756.

Male.—Length 4-5 mm.; of wing 4-4.5 mm. Face narrow, yellowish, more white near the palpi. Front shining green. Antennae 187329-21---13

(fig. 133) yellow, rather long; third joint more or less blackened at tip, a little longer than wide, somewhat oval in outline, but pointed at tip. Proboscis brown; palpi yellow. Lateral and inferior orbital cilia white, about five of the upper cilia on each side black.

Thorax green with coppery or bronze reflections; dorsum slightly dulled with grayish pollen; pleurae dulled with white pollen. Abdomen green with bronze reflections, its sides with white pollen and with yellowish hairs on second and third segments. Hypopygium black; its lamellae (fig. 133a) of moderate size, somewhat triangular in outline, but rather suddenly narrowed at base, whitish with a very narrow black border on apical margin, this black widens at upper and lower corners, jagged and bristly at apex, fringed above with little black hairs.

Fore coxae pale yellow, their anterior surface covered with white pollen and minute white hairs. Middle and hind coxae yellow with the outer surface more or less blackened. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter ciliated on the lower inner edge with a few long yellowish hairs, the longest of which are longer than the width of the femora. Posterior tibiae very little thickened, their inner surface with a glabrous stripe on basal half. Fore tarsi about one and a half times as long as their tibiae, black from the tip of the first joint, which is about equal in length to the two following joints taken together, third nearly as long as second, fifth scarcely as long as fourth. Middle tarsi about as long as their tibiae, black from the tip of the first joint, which has a large bristle on upper side at apical third. Hind tarsi wholly black, a little longer than their tibiae. Calypters and halteres yellow, the former with yellow cilia, sometimes there may be a black hair among them.

Wings grayish, a little tinged with yellowish brown in front; costa scarcely enlarged at tip of first vein, last section of fourth vein a little bent before its middle; hind margin of wing a little indented at tip of fifth vein; rather evenly rounded, but the anal angle somewhat prominent.

Female.—Face wider than in the male but narrow for a female; the front in one specimen is blue; fore tarsi but little longer than their tibiae; fore coxae with more or less black hairs on inner half of their anterior surface; hind tibiae without the glabrous stripe on inner surface; hind femora without cilia below, but with a row of little delicate white hairs on lower inner edge; otherwise as in the male. Middle tibiae with three bristles below, one pair at apical third and one bristle at basal third.

Redescribed from many specimens. The Aldrich collection contains specimens from Westville, New Jersey, August 14; Philadelphia, Pennsylvania, August 20; Delaware Water Gap, New Jersey,

July (Johnson); Franconia, New Hampshire; Sheridan, Wyoming (Metz); New Bedford, Massachusetts (Hough); Wisconsin; Seattle, Washington, Olga, Washington, July 14; Lafayette, Indiana, July 3 and August 21. I have it also from Downie Creek, Selkirk Mountains, British Columbia, August 9; Little Valley, New York, July 31; Niagara Falls, New York, September 8; Erie County, New York, July 13-September 6; Waubamic, Ontario, August 7; Kearney, Ontario. August 3; Lake McDonald, Montana, August 14; Priest Lake, Idaho, August 1 (Melander).

Type locality.—New York. Aldrich reports it from Massachusetts, Pennsylvania, New Jersey, and South Dakota; Melander and Brues from Illinois and Wisconsin; Chagnon, from Montreal, Quebec; Johnson, from Dunfield, New Jersey, July 14; and Westville, New Jersey, August 14.

No. 134. DOLICHOPUS VARIABILIS, var. GRACILIS, Aldrich.

Dolichopus gracilis Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 15.—Melander and BRUES, Biol. Bull., vol. 1, 1900, p. 148.

The description of variabilis answers for gracilis in every particular except as to the color of the calypters, which is yellow in variabilis and black in gracilis; it is often partly yellow in this form, so I am placing this as a variety of variabilis. (Fig. 134, wing).

I have seen the type specimen taken at Philadelphia, Pennsylvania, August 4, and specimens taken at Cuyhoga Falls, Ohio, August 10, by W. V. Warner; Beverly, Massachusetts, October 9; Erie County, New York, July 27-September 3; Kearney, Ontario, August 1.

Type.—In collection of J. M. Aldrich.

No. 135. DOLICHOPUS LUTEIPENNIS Loew.

Dolichopus luteipennis LOEW, Neue Beitr., vol. 8, 1861, p. 18; Mon. N. Amer. Dipt., pt. 2, 1866, p. 51.—MELANDER and BRUES, Biol. Bull., vol. 1, 1900, p. 148.

Male.—Length 4.5-5 mm.; of wing the same. Face rather narrow, silvery white, a very little yellowish near the antennae. Front shining green with a very little gray pollen. Antennae yellow; third joint about as long as wide, a little darkened and pointed at tip; arista dark brown, not quite as long as the antennae. Lateral and inferior orbital cilia pale yellow, only a few of the upper cilia black.

Thorax green; dorsum dulled with brownish gray pollen, its lateral edges narrowly yellow; pleurae more blackish with gray pollen. Abdomen green with more or less coppery or bronze reflections; its sides covered with grayish pollen, which extends upon the dorsum. Hypopygium black; its lamellae of moderate size, somewhat triangular but rounded on upper apical corner, apical margin narrowly bordered with black, jagged and bristly, fringed above with delicate little brown hairs.

Coxae yellow; middle pair more or less blackish on outer surface. fore coxae with minute, delicate, yellow hairs on the front surface. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter ciliated on lower inner edge with long yellowish white hairs, which are fully as long as the width of the femora, these are continued to the base by delicate little vellow hairs, apical fifth nearly bare below. Posterior tibiae with an elongated brown or black shining spot on each side at tip, which leaves only a vellow line above and below. Fore tarsi nearly one and three-fourths times as long as their tibiae, pale yellow with the last joint black; second and third joints each a little shorter than the joint preceding it, fourth and fifth joints of about equal length, taken together about as long as third. Middle tarsi about as long as their tibiae, becoming a little infuscated toward their tips. Hind tarsi wholly black; in one of the type specimens the hind basitarsi are yellow with black tips. Calvpters, their cilia, and the halteres vellow.

Wings (fig. 135) slightly tinged with yellowish gray, veins and costa yellowish brown, sometimes almost yellow; costa scarcely enlarged at tip of first vein; last section of fourth vein bent before its middle; hind margin of wing scarcely indented at tip of fifth vein; anal angle rather prominent but rounded.

Redescribed from the 2 type specimens and 3 males from South Dakota taken by J. M. Aldrich; and United States National Museum material from Kaslo, British Columbia, July 17.

Type locality.—Washington, District of Columbia. Osten Sacken reports it from Illinois, Melander and Brues from Vancouver Island.

There are two type specimens on the same pin, one of which has the hind tarsi wholly black, while in the other they are only slightly infuscated from the tip of the first joint. The antennae in both are wholly yellow.

Type.—Collection of J. M. Aldrich.

No. 136. DOLICHOPUS GREENEI, new species.

Male.—Length 4.5 mm.; of wing the same. Face of moderate width, silvery white. Front shining blue-green. Antennae dark yellow; third joint slightly darker and obtusely pointed at tip, about one and a half times as long as wide. Lower orbital cilia pale.

Thorax green; dorsum with bronze reflections in front, blue and violet on posterior portion, a little dulled with almost invisible brownish pollen; pleurae dulled with white pollen. Abdomen green with bronze reflections; the white pollen on its sides abundant. Hypopygium black with green reflection on basal portion; its lamellae (fig. 136a) moderately large, somewhat triangular in outline, but with the upper angle broadly rounded, whitish with rather wide black border on the apical and the rounded upper margin, jagged

and bristly on lower corner, otherwise fringed with delicate brown hairs on upper and apical margins.

Coxae yellow, middle pair a little darkened on outer surface; anterior pair with minute yellow hairs on the front surface. Femora and tibiae veltow. Middle and hind femora each with one preapical bristle, the latter ciliated on lower inner edge of apical half with rather stout yellow hairs, which are of nearly equal length and only two-thirds as long as the width of the femora; the cilia begin about the middle of the femora but do not reach the tip, otherwise the hind femora are nearly glabrous on their lower half, having only some very minute yellow hairs. Posterior tibiae a little thickened; inner surface glabrous on basal half, the glabrous portion gradually narrowing to form a line just inside of the inner row of large bristles which reaches the tip. Fore tarsi one and three fourths times as long as their tibiae, plain, slender, first three joints yellow, each a little shorter than the joint preceding it, the first two together fully as long as the tibia, fourth joint black, about half as long as the third, fifth a little shorter than the fourth, black at base, yellowish at tip. Middle tarsi one and a fourth times as long as their tibiae, infuscated from the tip of the first joint, still the base of second and third joints paler; middle basitarsi with a small bristle at apical third on upper edge. Hind tarsi black from the tip of the first joint, which has two large bristles on upper surface. Calypteres and halteres yellow, the former with black cilia,

Wings (fig. 136) grayish; costa without an enlargement at tip of first vein, somewhat yellowish on inner edge; last section of fourth vein bent near basal third, parallel with third from this point to its tip, the third vein not being bent backward at tip; hind margin of wing scarcely indented at tip of fifth vein; anal angle rather prominent but rounded.

Described from 1 male, which was taken at Chain Bridge, Virginia, June 27, by C. T. Greene, for whom the species is named.

Type.—Male, Cat. No. 23035, U.S.N.M.

The four species, variabilis Loew, gracilis Aldrich, luteipennis Loew and greenei, new species, are about the same size; antennae vellow and formed almost alike; have the hind femora ciliated with yellow hairs; the middle tibiae in all have three bristles below, two not far from apical third and one near basal third; middle basitarsi with a rather small but distinct bristle above; and the fore coxae in all have vellow hairs on the front surface.

The first two are alike, except that variabilis has yellow cilia on the calvpteres, and gracilis black cilia; they differ from the other two in having the fore tarsi shorter, about one and a fourth times as long as the tibiae, while in the last two the fore tarsi are about one and three-fourths times as long as the tibiae; in the first two they are black from the tip of the first joint, while in the last two they are yellow, except the last one or two joints. The species greenei differs from luteipennis in having the cilia of the hind femora shorter than the width of the femora, while in the latter it is longer, or at least as long, as the width of the femora; in luteipennis the third vein of the wing is distinctly bent backward at tip so as to approach the fourth a little, while in greenei the third vein is nearly straight and parallel with the fourth; the fourth and part of fifth joint of fore tarsi are black in greenei, but only the fifth is black in the other; the cilia of the calypteres is black in the former, yellow in the latter.

No. 137, DOLICHOPUS WHEELERI Melander and Brues.

Hygroceleuthus wheeleri MELANDER and BRUES, Biol. Bull., vol. 1, 1900, p. 126, figs.

Male.—Length 4.5 mm.; of wing 4 mm. Face long and narrow, silvery white. Front violet, more bluish along the orbits. Antennae vellow; third joint black, longer than wide, somewhat oval in outline, obtusely pointed at tip. Lower orbital cilia whitish, the black cilia descending nearly to the middle of the eye height.

Thorax green, scutellum blue in the center; anterior slope of the dorsum covered with white pollen; pleurae with gray pollen. Abdomen green with black incisures and coppery and bronze reflections on the hind margins of the segments; the white pollen on its sides extending upon the dorsum. Hypopygium black; its lamellae rather large, oval, whitish, apparently without a black border, a little jagged and bristly at apex.

Fore coxae yellow with minute black hairs on the anterior surface-Middle and hind coxae yellow with the outer surface largely black. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter nearly bare below. Posterior tibiae a little thickened; the glabrous stripe on upper surface distinct and reaches their whole length. Middle tibiae slender, nearly twice as ong as their femora, glabrous on their upper surface. Fore tarai one and a fourth times as long as their tibiae, black from the tip of the first joint, middle tarsi (fig. 137b) deep black, scarcely as long as the fore tibiae, their basitarsi fringed with long, deep black hairs, so as to give them an oval appearance, about half as wide as long, to the outside of the hairs, three-fourths as long as the remaining four joints taken together. Hind tarsi wholly black, scarcely at all yellow at base. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 137) grayish, slightly tinged with yellowish brown in front of third vein; costa not enlarged at tip of fifth vein; last section of fourth vein a little bent before its middle and with a slight cloud at the bend; hind margin of wing not indented at tip of fifth

vein; anal angle very prominent, and with a deep sinus between the tips of fifth and sixth veins, which forms something of a lobe at the anal angle.

Female.—A female in the United States National Museum which is in very poor condition is, no doubt, the female of this species; it is a very bright shining green with most of the thorax and front violet. Face not very wide for a female, but rather long, silvery white. Antennae yellow, scarcely darker at tip, third joint pointed at tip, longer than wide. Proboscis and palpi yellow. Middle tarsi plain, a little longer than their tibiae, black from the tip of the first joint, which has a large bristle above near apical third. Middle tibiae with three bristles below, two near apical third, and one near basal third. Hind tibiae wholly pale yellow; hind tarsi wholly black. Wings (fig. 137a) with the anal angle very prominent for a female, and without any trace of a lobe at tip of sixth vein and without any indication of the sinus found in the male.

Redescribed from 1 male in the United States National Museum, taken by Mrs. Slosson on Mount Washington, New Hampshire, and 1 female taken by Morrison, in the White Mountains, New Hampshire.

Type locality,—Woods Hole, Massachusetts. I have seen several males from New England in the collection of C. W. Johnson.

Type.—In American Museum of Natural History, New York City.

No. 138, DOLICHOPUS LONGIMANUS LOCK.

Dolichopus longimanus Loew, Neue Beitr., vol. 8, 1861, p. 14; Mon. N. Amer. Dipt., pt. 2, 1864, p. 38.—Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 10.— COQUILLETT, Proc. Wash. Acad. Sci., vol. 2, 1900, p. 425.—MELANDER and BRUES, Biol. Bull., vol. 1, 1900, p. 148.

Male.—Length 6-7.2 mm.; of wing 5-6.5 mm. Face moderately wide, pale yellowish to dark ocher yellow. Front dark green, slightly dulled with gray pollen. Antennae black, first joint usually a little yellowish at lower apical corner; third joint a little longer than wide, pointed at tip; inferior orbital cilia yellowish, the black cilia of the upper orbit descending to the middle of the eye.

Thorax green with a median, more or less bronze colored, stripe on the dorsum, which is covered with thin grayish pollen; pleurae dulled with gravish pollen. Abdomen green with bronze or reddish coppery reflections which are sometines wholly wanting; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black, its lamellae (fig. 138b) of moderate size, somewhat oval in outline, whitish with a broad black border on apical margin and on upper edge, jagged and bristly at lower apical corner, fringed on upper edge with black hairs.

Fore coxae yellow, blackened at base, on outer side the black reaches beyond the middle, clothed with black hairs on anterior

surface; middle and hind coxae black with extreme tips yellow. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter ciliated on lower inner edge for about onefourth their length, leaving the basal half and apical fourth bare, the longest of these hairs are about as long as the width of the femora. Posterior tibiae thickened, glabrous on inner surface for more than half their length, lower edge with a row of large bristles. Fore tarsi (fig. 138a) nearly twice as long as their tibiae, first four joints yellow, fifth black, compressed, a little longer than the fourth, somewhat oval in outline, fringed above with little black hairs; first joint fourfifths as long as the tibiae, second fully half as long as first, third a little shorter than second, fourth slightly more than half as long as third. Middle tarsi a little longer than their tibiae, black from the tip of the first joint, which has a large bristle near the middle of its upper edge, the middle tibiae have four bristles on lower surface, one pair near apical third and two single bristles preceding the pair. Hind tarsi wholly deep black, constrasting sharply with the wholly yellow tibia. Calypters, their cilia and the halteres yellow.

Wings (fig. 138) tinged with gray; costa with an elongated enlargement at tip of first vein; last section of fourth vein bent before its middle; third vein bent backward at tip, still its tip rather distant from the tip of fourth vein as the fourth is also bent back a little; hind margin of wing a little indented at tip of fifth vein, somewhat expanded between the tips of fifth and sixth veins; anal angle prominent.

Female.—Face wide, covered with whitish pollen; third antennal joint nearly round, still slightly pointed at tip; hind tarsi often yellow at base; fore coxae a little less black; bristle on middle basitarsus a little nearer the tip than in the male; hind femora without cilia, their tibiae without the glabrous surface on inner side and but little thickened; wings about as in the male, except that the costa is scarcely thickened at tip of first vein and are more yellowish.

Redescribed from many males and females. In the Aldrich collection are specimens from Polk County, Wisconsin, July, taken by Baker; Custer, South Dakota, and Bottineau, North Dakota, June 20, 1918, taken by J. M. Aldrich, Franconia, New Hampshire, taken by Mrs. Slosson; Hanover, New Hampshire, taken by C. M. Weed; and Kukak Bay, Alaska, July 4, 1899, taken by Kincaid. In the United States National Museum are specimens from Colorado, Alaska, and Woodstock, Virginia, June, 1897, taken by F. C. Pratt. I have taken it at Olean, New York, August 5; Ridgeway, Ontario, June 26–July 15; Niagara Falls, Ontario, July 31, 1910; Kearney, Ontario, July 3–9, 1909, and July 26, 1911.

Type localities.—English River, Canada; and West Point, New York. Melander and Brues report it from Massachusetts and Wisconsin.

Type.—In Museum of Comparative Zoology, Cambridge, Massachusetts.

A note on the mating habits of this species is given in the introduction.

No. 189. DOLICHOPUS SUBCILIATUS Loow.

Dolichopus subciliatus Loew, Mon. N. Amer. Dipt., pt. 2, p. 42.

The following description is a copy of Doctor Loew's:

Metallic-green, bright. Front metallic-green. Antennae black; on under side of the first joint I am not able to discover any lighter coloring; third joint rather blunt at the tip. Face grayish-yellow, palpi yellow. Cilia of the inferior orbit pale-yellowish. Hypopygium black; lamellae of medium size, ovate, white, with narrow black border, on the apical margin somewhat jagged and fringed with black bristles. The four posterior coxae blackish with yellow tip. Fore coxae yellow, only at the extreme basis somewhat blackened, upon the anterior side beset with very delicate black hairs, which do not reach to their base. Feet pale yellow. Hind femora with a bristle before the tip, upon the greater part of the under side sparsely ciliated with moderately long yellowish hairs. Hind tibiae stout, but not exactly thickened, not hairy upon the first half of the hind side [basal half of inner surface]; brownish at extreme end. Fore tarsi twice as long as the tibiae; their four first joints very slender, yellow; the first joint nearly as long as the three following ones together; the third somewhat shorter than the second; the fourth hardly half as long as the third, the fifth joint black, flattened, broad, still not as large as in D. batillifer: upon its upper edge it is beset with appreceed minute black hairs. Middle tarsi from the tip of the first joint blackened. Hind tarsi entirely black. Cilia of the tegulae [calypters] yellowish-white. Wings hyaline, somewhat grayish, at the tip of the first longitudinal vein with a long but not very stout swelling, which gradually merges into the costa; fourth longitudinal vein not broken.

Length 0.21-0.22, wing 0.25 inch. Fort Resolution, Hudson's Bay Territory.

The species has not been recognized since it was described. It is probably an Arctic species and as that region has not been visited much by collectors it has never been found. The type at the Museum of Comparative Zoology has been completely destroyed by museum pests.

No. 140. DOLICHOPUS AMPLIPENNIS, new species.

Male.—Length 5.5-6 mm.; of wing 6-6.5 mm. Face rather wide, yellowish gray, almost ocher yellow, a little paler on the lower portion. Front shining blue-green. Antennae wholly black or very slightly tinged with yellow on lower edge of first joint; third joint somewhat oval, a little longer than wide, obtusely pointed at tip. Lower orbital cilia yellow, the black cilia descending below the middle of the eye.

Thorax green with bronze brown reflections which form wide vittae on the dorsum, which is covered with brown pollen leaving the bronze vittae more shining; the pollen along the front edge is more gray. Abdomen green with coppery reflections; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black; its lamellae (fig. 140b) large, elongate oval, twice as long as wide, yellowish, with wide black border on apical margin,

jagged and bristly on lower half of apical edge, fringed above with dark hairs.

Fore coxae yellow, blackened at base on outer surface for one-third their length, anterior surface with numerous minute black hairs and some delicate pale hairs on upper outer corner; middle and hind coxae black with yellow tips, sometimes narrowly yellowish at base. Femora and tibiae vellow. Middle and hind femora each with one preapical bristle, the latter ciliated on lower inner edge for about one-fourth their length with dense yellow hairs, which are as long as the width of the femora and leave the basal half and apical fourth bare. Posterior tibiae thickened, a little compressed, lower edge with a row of bristles of uneven length, the longest being as long as those on upper edge; the glabrous stripe on upper surface narrow and not conspicuous, but with a broad glabrous space on the lower part of the basal half of the inner surface, their tips not at all infuscated. Middle tibiae with three bristles below, one pair at apical third and one bristle at basal third, sometimes with one more bristle near the middle. Fore tarsi (fig. 140a) twice as long as their tibiae, the first joint nearly as long as the tibia and a little longer than the three succeeding joints together; first four joints vellow, fourth more than half as long as third and slightly widened at tip; fifth as long or slightly longer than fourth, black, compressed, widest near the apex, where it is slightly more than half as wide as long, somewhat triangular; the sides of this joint have a slight yellowish or reddish luster in certain lights. Middle tarsi nearly one and a half times as long as their tibiae, the first two joints being nearly as long as the tibia, black from the tip of the first joint, still the base of second a little yellowish; middle basitarsi with a large bristle on upper side. Hind tarsi black, sometimes yellowish on basal portion of first joint. Calypters, their cilia, and the halteres yellow; sometimes there are a few black hairs among the cilia.

Wings (fig. 140) grayish, veins yellowish; costa with a slight elongated enlargement at tip of first vein; last section of fourth vein bent at basal third; hind margin of wing a little indented at tip of fifth vein, a little widened between the tips of the fifth and sixth veins; anal angle prominent.

Described from 2 males from Colorado.

Type.—Male, Cat. No. 23036, U.S.N.M.

This species differs from subciliatus Loew in having the cilia of the hind femora confined to about one-fourth of the lower edge, while in that species it extends nearly the whole length of the femora; it also differs in other respects a little.

No. 141, DOLICHOPUS SPLENDIDUS Loew.

Dolichopus splendidus LOEW, Neue Beitr., vol. 8, 1861, p. 21; Mon. N. Amer. Dipt., pt. 2, 1864, p. 44.—MELANDER and BRUES, Biol. Bull., vol. 1, 1900, p. 148.

Male.—Length 5-5.5 mm.; of wing 4.5 mm. Face rather wide, yellowish white, paler below. Front shining green. Antennae black; first joint usually wholly black, but sometimes the lower apical corner is distinctly yellow; third joint longer than wide, rounded at tip, sometimes obtusely pointed. Lateral and inferior orbital cilia vellowish.

Thorax bright shining green, sometimes with reddish coppery spots before the suture and along the median line of the dorsum; dorsum distinctly white pollinose along the front; pleurae dulled with white pollen. Abdomen green, sometimes with coppery reflections. Hypopygium black; its lamellae (fig. 141a) moderately large, somewhat round in outline, but straight below, whitish with narrow black border on apical margin, jagged and bristly on lower half of the apical edge, fringed with black hairs above.

Fore coxae wholly yellow, with very minute black hairs on their anterior surface. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter ciliated on lower inner edge for nearly one-half their length with yellow hairs, the longest of which is longer than the width of the femora. Posterior tibiae a little thickened, a little brownish on the sides at tip. Fore tarsi (fig. 141b) one and a half times as long as their tibiae; the first two joints taken together nearly equal in length to the tibia; first joint a little longer than the second and third together, third a little shorter than the second, fourth about half as long as second, slightly compressed and almost whitish, fifth joint black, about as long as third, compressed, widest near the tip, where it is about as wide as long, somewhat triangular in outline; first three joints yellow. Middle tarsi a little longer than their tibiae, blackened from the tip of the first joint, which has a large bristle above. Hind tarsi wholly black. Calypters, their cilia, and the halteres vellow.

Wings (fig. 141) grayish; costa with an elongated enlargement at tip of first vein; last section of fourth vein a little bent just before its middle; hind margin of wing scarcely indented at tip of fifth vein; anal angle prominent.

Female.—Face wide, whitish; fore tarsi plain, more or less infuscated from the tip of first joint, the last three joints black; they are a little longer than their tibiae, fifth joint as long as the third, which is a little shorter than second, fourth shorter than fifth; middle tibiae with three bristles below, one pair at apical third and one bristle at basal third; hind femora without cilia below; wings about as in the male; color of middle and hind legs about as in the male; cilia of the calypters yellow.

Redescribed from many males and females. The Aldrich collection has specimens from Algonquin, Illinois, (W. A. Nason); Agricultural College, Michigan, June 15, 1889; Brookings, South Dakota; Hammond, Indiana, June 24, 1915; Michigan City, Indiana, June 29, 1915 (last three lots collected by Aldrich); and Montreal, Quebec, June 15, 1901. I have taken specimens at Ridgeway, Ontario, June 7–July 15; Chatham, Ontario, June 11; Kearney, Ontario, July 2–7, 1909; Melander has specimens from Chicago, Illinois; and Waubamic, Ontario, June 14. In the United States National Museum are specimens from Dead Run, Fairfax County, Virginia, June 22, 1915; Colorado, (Baker); Tower City, North Dakota, June 15, (G. I. Reeves); and from Beverly, Massachusetts, June 19 (Riley). I saw many specimens in the collection of C. W. Johnson from New England.

Type locality.—White Mountains, New Hampshire. Melander and Brues report it from Ontario, Michigan, and Illinois.

The female of this species differs from that of splendidulus Loew in having the bend in the last section of the fourth vein of the wing very near its middle, while in that species it is considerably before the middle.

No. 142, DOLICHOPUS SPLENDIDULUS Loew.

Dolichopus splendidulus Loew, Cent., vol. 5, No. 82; Mon. N. Amer. Dipt., pt. 2, 1864, p. 327.—Melander and Brues, Biol. Bull., vol. 1, 1900, p. 148.

Male.—Length 4.5-5 mm.; of wing 5-5.3 mm. Face rather wide, pale yellowish, more white below. Front shining green. Antennae wholly black; third joint a little longer than wide, obtusely pointed at tip. Lateral and inferior orbital cilia yellowish, about seven of the upper cilia on each side black.

Thorax green with grayish pollen, which sometimes dulls the dorsum, but leaves three vittae more shining. Abdomen green with very narrow black incisures, covered with white pollen which forms spots on the sides of the segments. Hypopygium black; its lamellae (fig. 142b) of moderate size, somewhat round in outline, whitish with narrow black border on upper and apical margins, jagged and bristly at apex, fringed with little black hairs on upper edge.

Fore coxae yellow, scarcely darkened at base on outer side, with little black hairs on the anterior surface. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter ciliated with rather scattering yellowish hairs for about one-third their length, beginning at the middle of the lower inner edge but not quite reaching the tip, the longest hairs not quite as long as the width of the femora. Posterior tibiae only slightly thickened, their tips not or scarcely darkened at all; inner surface with a glabrous space on basal half. Fore tarsi

(fig. 142a) fully one and a half times as long as their tibiae, the first two joints taken together being nearly as long as the tibia; first three joints yellow, fourth whitish, fifth black; first joint a little longer than the second and third together, third a little shorter than the second, fourth about three-fourths as long as the third, a little compressed and widened at tip, fifth nearly or quite as long as second, much compressed and widened, somewhat oval in outline, still widest near the tip, slightly more than one-half as wide as long. Middle tarsi about one and a fourth times as long as their tibiae, black from the tip of the first joint, which has a large bristle above. Hind tarsi wholly black. Calypters, their cilia and the halteres yellow.

Wings (fig. 142) grayish; costa with a small knotlike enlargement at tip of first vein; last section of fourth vein a little bent some distance before its middle; hind margin of wing a little indented at tip of fifth vein; anal angle prominent; third vein bent backward a little at tip.

Female.—Face wide, yellowish white; legs and feet as in the female of splendidus; wing as in the male, the bend in the last section of fourth vein being beyond basal third but some distance before the middle.

Redescribed from the type specimens and 5 males and several females. The males were taken as follows: 2 in Polk County, Wisconsin, by Baker, in July, in the Aldrich collection; I have a specimen from Bretton Woods, New Hampshire, taken by E. P. Van Duzee; and I took 2 at Kearney, Ontario, July 5, 1909.

Type locality.—White Mountains, New Hampshire, July. Melander and Brues report it from Illinois and New Hampshire; C. W. Johnson has several specimens from New England in his collection.

Types.—In Museum of Comparative Zoology, Cambridge, Massa-

Splendidus and splendidulus may be separated in the males by the enlargement of the costa at tip of first vein. In splendidus it is elongated, and in splendidulus it is smaller and knotlike; the fifth joint of fore tarsi is also somewhat different in the two species, for in the former it is about as long as the third joint and somewhat triangular, while in splendidulus it is about as long as the second joint and oval in outline; the cilia on lower edge of hind femora are a little longer than the width of the femora in splendidus, while in the other form it is scarcely as long as the width of the femora.

No. 143. DOLICHOPUS NUDUS Loew.

Dolichopus nudus LOEW, Mon. N. Amer. Dipt., pt. 2, 1864, p. 41.

The following is copied from Doctor Loew's original description:

Male.—Metallic-green, bright. Front metallic-green. Antennae black; the under side of the first joint yellowish-red; third joint rather blunt at the tip. Face ocheryellow; palpi yellow. Cilia of the inferior orbit pale yellowish. Hypopygium black; lamellae of medium size, ovate, white, with a rather narrow black border, on the apical margin jagged and fringed with black bristles. Four posterior coxæ blackish with yellow tip. Fore coxae yellow, only somewhat blackened at the extreme basis, beset upon the anterior side with delicate black hairs, which reach nearly to their base. Feet pale yellow. Hind femora before the tip with a bristle, upon the under side only with very short minute pale hairs. Hind tibiae stout but not exactly thickened, upon the first half of the hind side without hairs, at the extreme tip brownish. Fore tarsi twice as long as the tibiae; their first four joints very thin, yellow; first joint as long as the three following ones together; third somewhat shorter than the second; the fourth hardly half as long as the third; the fifth joint black, flattened, broad, still not as large as in D. batillifer: upon its upper margin it is beset with appressed minute black hairs. Middle tarsi from the tip of the first joint blackened; hind tarsi entirely black, Cilia of the tegulae yellowish-white. Wings hyaline; near the tip of the first longitudinal vein with a long but not very thick swelling, which gradually merges into the costa; fourth longitudinal vein not broken.

Femals.—Wings and feet plain, fore tarsi from the tip of the first joint blackened. All the rest as in the male.

●The single type specimen which I found at the Museum of Comparative Zoology in January, 1919, had been entirely destroyed, except the wings, which still adhere to the pin; from which I made the following notes:

The costa is distinctly enlarged, the enlargement beginning a little before the tip of the first vein and gradually tapering to the tip of the costa, this enlargement although distinct is rather small; the bend in the last section of the fourth vein is just beyond its basal third and beyond this bend the fourth vein is distinctly arcuated; the third vein is also considerably and rather evenly arcuated from a point nearly opposite the cross-vein to its tip (this is a rather peculiar character); the second vein also shows a little of this arcuation; the hind margin of the wing is quite evenly rounded, the anal angle being rounded, not at all prominent; the hind margin at the tip of the fifth vein is a little drawn in from both sides so as to form a slight sinus, but there is scarcely an indentation at tip of fifth vein in the usual sense used in these descriptions.

Type locality.—Fort Resolution, Hudson Bay Territory.

No. 144. DOLICHOPUS DISCIPER Stannius.

Dolichopus discifer Stannius, Isis, 1831, p. 37.—Schiner, Fauna Austr., vol. 1, p. 216.—Loew, Mon. N. Amer. Dipt., pt. 2, 1864, p. 71.—Coquillett, Proc. Wash. Acad. Sci., vol. 2, 1900, p. 423.—Lundbeck, Dipt. Danica, vol. 4, 1918, p. 95.

Dolichopus tanypus Loew, Neue Beitr., vol. 8, 1861, p. 71.

Male.—Length, 4.75-5.5 mm.; of wing, 5-5.5 mm. Face of moderate width, rather long, silvery white, sometimes a little yellowish on the upper part. Front shining green. Antennae black; first joint yellow below on lower half or more; third joint large, about two and a half times as long as wide, somewhat elliptical in outline, rather pointed at tip; arista inserted beyond the middle of the third joint.

Lateral and inferior orbital cilia white, about six of the upper cilia on each side black.

Thorax green with bronze reflections, which sometimes form a median vitta on the dorsum; dorsum dulled with a little grayish pollen; pleurae dulled with white pollen. Abdomen green with coppery reflections and black incisures; the white pollen on the sides extends over the dorsum. Hypopygium black; its lamellae of moderate size, somewhat oval, whitish with narrow black border on apical and upper margins, jagged and bristly at apex, fringed above with black, below with a few pale hairs.

Fore coxae yellow, their anterior surface covered with silvery pollen and minute white hairs. Middle and hind coxae black with yellow tips. Femora and tibiae vellow. Middle and hind femora each with one preapical bristle, the latter without cilia, but with minute vellow hairs below. Posterior tibiae a little infuscated at tip, especially on inner side, scarcely thickened, the usual glabrous stripe on upper surface distinct, but a little broken by a few little hairs; there is also a glabrous line just inside of the inner row of large bristles; middle and hind tibiae each with one bristle below. Fore tarsi (fig. 144a) nearly twice as long as their tibiae, slender, first four joints yellow, each more slender than the preceding one; first nearly three-fourths as long as the tibiae, third and fourth of nearly equal length, each a little shorter than the second; fifth joint compressed, black with the extreme base white, nearly half as long as the fourth, oval, a little longer than wide. Middle tarsi one and a fourth times as long as their tibiae, infuscated from the tip of the first joint; first joint without a bristle above. Hind tarsi wholly black, or sometimes the first joint a little reddish at base. Calvpters and halteres vellow, the former with black cilia.

Wings (fig. 144) grayish, sometimes with a slight yellowish brown tinge in front of the third vein; costa slightly enlarged at tip of first vein and tapering to its tip; last section of fourth vein a little bent near its basal third; third and fourth veins distinctly approaching each other toward their tips; hind margin of wing a little indented at tip of fifth vein, and with a slight sinus near sixth vein; wing slightly narrowed toward the base, still the anal angle rather prominent, forming on account of the sinus a small lobe-like projection.

Female. - Face wide, grayish white; third antennal joint only a little longer than wide, pointed at tip; fore coxae with a few minute black hairs along the inner edge; fore tarsi plain, a little longer than their tibiae, first four joints dark yellow, fifth joint black, all the joints of decreasing length; middle tarsi only a little longer than their tibiae; hind margin of wing more evenly rounded than in the male, the anal angle rounded; wing not narrowed toward the base. Otherwise about as in the male.

Redescribed from many males and females. One pair were from Europe, the others were taken as follows: St. Hilaire, Quebec, July 1; Parry Sound, Ontario, June 4; Kearney, Ontario, July 3; Brule Lake, Ontario, August 3; Ridgeway, Ontario, June 7; Colden, New York, July 19; Polk County, Wiconsin, July; Kodiak, Alaska, July 20; Bond Lake, Ontario, July 16; Toronto, Ontario, July 18; Waubamic, Ontario, June 14; Lyndon, Vermont, August 22.

Loew reports it from English River, Canada; Red River; Sitka,

Loew reports it from English River, Canada; Red River; Sitka, Alaska; and the White Mountains, New Hampshire. Coquillett reports it from Alaska, several places. It is found in middle and northern Europe. Location of type unknown.

No. 145. DOLICHOPUS BOREUS, new species.

Male.—Length 5 mm.; of wing 4.7 mm. Face wide, scarcely narrowed below, silvery white, slightly tinged with gray, long, reaching nearly to the lower corner of the eye. Front green or blue-green, slightly dulled, antennae (fig. 145) black; first joint broadly yellow below; third joint fully twice as long as wide, pointed at tip, with the subapical arista inserted just above the point. Lateral and inferior orbital cilia yellowish white, about eight of the upper cilia on each side black.

Thorax green, or bronze brown with green reflections; dorsum dulled with brown pollen, pleurae with grayish pollen. Abdomen green, sometimes bronze brown with purple reflections. Hypopygium black; its lamellae of moderate size, somewhat oval in outline, but rather angulated at base above, not much longer than wide; yellowish with a black apical border, jagged and bristly at apex.

Fore coxae yellow with a blackish spot at base on outer side, their anterior surface covered with yellow hairs; there are a few little black hairs along the inner edge. Middle and hind coxae black with vellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter without cilia below; the little black hairs on their sides descend to the lower edge, although the lower ones are very minute; they have a few rather long black hairs at base above. Posterior tibiae a little thickened especially at tip, where they are blackened a little, most on inner surface; the glabrous stripe on upper surface is distinct and reaches the tip; on the inner surface there is a glabrous space just inside of the inner row of bristles, which is wide on basal portion and tapers to a narrow line at tip, uniting there with the stripe on upper edge. Fore tarsi (fig. 145a) nearly twice as long as their tibiae, first two joints black or blackish, third and fourth yellow, fifth black; first joint one and a fourth times as long as the second; second, third, and fourth of nearly equal length, the third being slightly the shortest; fifth small, compressed, oval, but little longer than wide, not over one-fourth as long as fourth. Middle tarsi one and a third times as long as their tibiae, black from the tip

of the first joint, which is without a bristle above and is nearly as long as the three succeding joints taken together; fifth joint about three fourths as long as fourth. Hind tarsi wholly black. Middle and hind tibiae each with one large bristle below near apical fourth. Calypters and halteres yellow, the former with black cilia.

Wings grayish; costs with a slight elongated enlargement at tip of first vein; last section of fourth vein slightly bent at basal third; third and fourth veins a little convergent toward their tips; anal angle rather prominent but rounded.

Described from 6 males taken at Ungava Bay, Labrador, July 22-29, by L. M. Turner.

Type.—Male, Cat. No. 23037, U.S.N.M.

While this species has a striking resemblance to discifer Stannius, still it differs in many points. The face is wider; the arista is placed much nearer the tip of third antennal joint; the hind femora have no yellow hairs on the lower edge of their sides; the first two joints of fore tarsi are black and quite thick; the tips of fore tibiae are slightly brownish; and the wings are not narrowed at their roots.

No. 146. DOLICHOPUS ANGUSTATUS Aldrich.

Dolichopus angustatus Aldrich, Kansas Univ. Quart., vol. 2, p. 15.

The following is a copy of Doctor Aldrich's description. I have not seen the species, but Professor Melander has it in his collection. The drawings are from this specimen, which was taken at Woods Hole, Massachusetts.

Male. Antennae black, first joint in part yellow, third joint very long and wide with a sharp point; cilia of inferior orbit pale, of tegulae black, last joint of fore tarsus enlarged.

Face grayish yellow, front shining violet; first joint of antennae slender, arista inserted beyond the center of the third joint. Thorax bright bluish green, with a bronze stripe each side above the root of the wing, and a very narrow one in the middle; pleurae dark green, light dusted. Abdomen somewhat bluish green, more bronze before the incisures. Hypopygium black, the lamellae whitish, rounded with a black margin, jagged near the apex, and with curved black bristles. Fore coxae yellow, with small black hairs in front near the inner side, and some white dust. Middle and hind coxae yellow, the former considerably, the latter slightly, brownish toward the base. Femora and tibiae yellow, the hind femora not ciliated. Fore tarsi [fig. 146a] nearly twice as long as the tibiae, not very slender, the first four joints plain, yellow; fifth joint as long as the third, black, flattened; fourth somewhat flattened, but not otherwise modified; middle tarsi blackened from the tip of the first joint; hind tarsi wholly infuscated, still at the base not decidedly black; the color suggests, that the specimen may be immature. Wings [fig. 146] subhyaline, rounded at apex, the widest part beyond the middle, narrowed toward the base. Beyond the double flexure the fourth vein runs in a gentle curve parallel with the third vein, ending barely before the apex. Length 5 mm.; of wing 4.2 mm.

One male, Massachusetts (U. K.). Type.—In University of Kansas.

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No. 147. DOLICHOPUS COMPACTUS, new species.

Male.—Length 5.5 mm.; of wing the same. Face wide, only a little narrowed below, grayish white. Front green with bronze reflections. Antennae black; first joint yellow with a narrow black upper edge; third joint somewhat conical, about as long as wide, pointed at tip. Lateral and inferior orbital cilia yellowish white, about eight of the upper cilia on each side black.

Thorax green with coppery reflections; dorsum dulled with gray pollen; pleurae with whitish pollen. Abdomen green with coppery reflections and narrow black incisures; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black; its lamellae large, nearly twice as long as wide, white with a broad black border on apical margin and extending upon the upper edge, jagged and bristly on lower half of apical margin, fringed above with black hairs, below with a few yellow hairs.

Fore coxae yellow with a blackish spot at base on outer side, their anterior surface covered with conspicuous black hairs, only a few pale ones on upper outer corner. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter without cilia, but with two or three rows of minute vellow hairs on the lower portion of their inner surface. Posterior tibiae a little blackish at extreme tip, only a little thicker than the others, the inner row of large bristles on upper surface with six, the outer with eight bristles, the usual glabrous stripe between the rows broken by little hairs; middle tibiae with one large bristle below near apical third and another near it on the lower part of the front surface. Fore tarsi (fig. 147a) one and three-fourths times as long as their tibiae, black from the tip of the first joint; first two joints taken together as long as the tibia, second three-fourths as long as first, third three-fourths as long as second, fourth half as long as third; first three joints slender, tip of third only slightly widened, last two compressed, fourth a little widened, fifth a little more so, widest near the tip, where it is scarcely half as wide as long; it is as long as the third; pulvilli white, rather conspicuous. Middle tarsi nearly one and a half times as long as their tibiae, black from the tip of the first joint, which has a large bristle above near apical third. Hind tarsi wholly black, a little longer than their tibiae. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 147) grayish, a little tinged with brown in front of third vein; costa not enlarged at tip of first vein; last section of fourth vein rather sharply, but not greatly, bent before its middle; third vein bent backward a little near the tip; hind margin of wing scarcely indented at tip of fifth vein; anal angle prominent and extending a little toward the root of the wing; wing of somewhat equal width.

Described from 1 male taken at Hood River, Oregon, July 4, 1917, by F. R. Cole.

Type.—Male, Cat. No. 23038, U.S.N.M.

No. 148. DOLICHOPUS WALKERL new species.

Male.—Length 4.5-5.5 mm.; of wing 4.5-5 mm. Face rather wide, a little narrowed below, yellowish. Front green with bronze reflec-First antennal joint yellow with the upper edge black; second and third black, the latter longer than wide, somewhat oval, a little pointed at tip. Proboscis black; palpi yellow. Lateral and inferior orbital cilia pale yellow, about six of the upper cilia on each side black.

Thorax green with bronze reffections; dorsum dulled with yellowish gray pollen, which becomes more gray along the front edge; pleurae dulled with white pollen. Abdomen green with coppery reflections; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black; its lamellae large, fully twice as long as wide, somewhat oval, white with wide black border on apical margin, jagged and bristly at apex, fringed above with little black hairs, below with a few pale hairs.

Fore coxae wholly yellow or nearly so, their anterior surface with little black hairs. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter not ciliated below. Posterior tibiae but little thicker than the others, not or scarcely at all infuscated at tip. Fore tarsi (fig. 148a) one and a fourth times as long as their tibiae; first three joints yellow, first about equal to the three following joints taken together, second joint three-fourths as long as first, third half as long as second or sometimes more, fourth black, about one-third as long as third, a little compressed, as wide as long, fifth joint black, compressed, a little longer than third, somewhat oval, nearly straight below, obliquely truncate at tip, the apex extending beyond the claws; pulvilli white, consipcuous. Middle tarsi a little longer than their tibiae, black from the tip of the first joint, which has a large bristle above, their tibiae with three, sometimes four bristles below, one pair at apical third and one or two bristles before them. Hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 148) grayish; costa without an enlargement at tip of first vein; last section of fourth vein bent beyond its basal third; hind margin of wing not indented at tip of fifth vein; anal angle of wing prominent.

Female.—Nearly as in the male, except that the face is wider and grayish white; the fore tarsi are plain, a little longer than their tibiae, first joint as long as the remaining joints taken together, blackened

from the tip of the first joint, still the second and third joints are a little yellowish at base.

Described from 7 males and 3 females. Five males and the 3 females were taken in Colorado, one of them at Longview, June 24, by E. C. Jackson; 1 male at Cloudcroft, New Mexico, June 17, 1902; and 1 male at Dauphin, Manitoba, July 22, by Dr. E. M. Walker, to whom the species is dedicated.

Type.—Male, Cat. No. 23039, U.S.N.M., from Colorado.

No. 149. DOLICHOPUS SPECIOSUS, new species.

Male.—Length 4 mm.; of wing 3.8 mm. Face rather wide, dark golden yellow. Front green, dulled with brownish pollen. Antennae black; lower half or first joint yellow; third joint nearly orbicular in outline, arista inserted near its base. Palpi small, yellowish. Lateral and inferior orbital cilia yellowish white, about eight of the upper cilia on each side black.

Thorax dark green, a little dulled with gray pollen, which is almost invisible on the dorsum and leaves a narrow median vitta more shining green. Abdomen dark green; the white pollen on its sides extending upon the dorsum. Hypopygium black; its lamellae rather large, oval, a little longer than wide, whitish with black border.

Fore coxae yellow with a blackish spot at base on outer side, anterior surface covered with little black hairs; middle and hind coxae black with their tips narrowly yellow. Femora and tibiae yellow. Middle and hind femora each with one not very large preapical bristle, the hind femora without cilia below, but with the little black hairs on inner surface extending to the lower edge. Posterior tibiae scarcely at all thickened, their tips black for about one-fifth their length, but this black not sharply limited and extending further · towards the base on upper edge. Fore tarsi (fig. 149a) one and a fourth times as long as their tibiae, infuscated from the base, becoming darker apically, fourth and fifth joints black; second joint less than half, third a fourth as long as the first, fourth a little shorter than the third, a little compressed and widened, especially at tip; fifth joint compressed, about three-fourths as long as first, oval, about twice as long as wide, nearly straight below, fringed above with little black hairs. Middle tarsi a little longer than their tibiae, blackened almost from their base, still the first joint a little yellowish. Hind tarsi wholly black, about one and a fourth times as long as their tibiae. Calypters and halteres yellow, the former with black cilia. middle tibiae with three bristles below, one pair at apical third and one bristle at basal third, their basitarsi with a large bristle at or near apical third of upper surface.

Wings grayish (fig. 149); costa with a small knotlike enlargement at the tip of first vein; last section of fourth vein bent before its

middle; third vein only slightly bent backward at tip; hind margin of wing slightly indented at tip of fifth vein; anal angle prominent.

Described from 1 male taken on the top of the Las Vegas Range. New Mexico, June 28, 1902 (Cockerell); and one male taken at Geneva Park, Grant, Colorado, July 21, 1916 (E. C. Jackson), at an elevation of 10,000 feet.

Type.—Male, Cat. No. 23040, U.S.N.M., from New Mexico.

This is much like walkeri, but the joints of the fore tarsi are of different lengths, the wings have a small enlargement at tip of first vein and their hind margin is straighter, the first antennal joint is not distinctly black above, the fore coxae have a large blackish spot at base on outer side, and the hind tibiae are more blackened at tip.

No. 150. DOLICHOPUS PROCERUS, new species.

Male.—Length 4.5-5 mm.; of wing the same. Face rather wide, a little narrowed below, yellowish gray. Front green with coppery reflections, sometimes blue-green, rather shining. First antennal joint yellow, sometimes narrowly black on upper edge; second and third joints black, third one and a half times as long as wide, somewhat oval, usually a little pointed at tip. Lateral and inferior orbital cilia yellowish, about six of the upper cilia on each side black.

Thorax shining green, usually with a median coppery vitta on the dorsum, sometimes with blue reflections; pleurae dulled with white pollen. Abdomen green with bronze, coppery, or blue reflections; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black; its lamellae large, somewhat oval in outline, nearly twice as long as wide, whitish with a black border which is wide on apical, narrow on upper margin, a little jagged and bristly on lower apical corner, fringed above with little black hairs.

Fore coxae yellow with the extreme base a little blackened, their anterior surface with little black hairs. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter without cilia below, the hairs on their sides wholly black. Posterior tibiae slightly thickened, brownish toward the tip on inner side, hairs on inner surface longer and denser on apical half. Fore tarsi (fig. 150a) nearly one and three-fourths times as long as their tibiae; first three joints yellow, slender, first two of about equal length, third fully half as long as second, fourth a little compressed, black, about as wide as long, one-third as long as third; fifth joint black, compressed, somewhat round in outline, only a little longer than wide, as long as third joint, fringed above with little hairs; pulvilli white, conspicuous. Middle tarsi one and a fourth times as long as their tibiae, black from the tip of the first joint, which has a large

bristle above near apical fourth. Hind tarsi wholly black. Calypters and halteres yellow, the latter ciliated with black.

Wings (fig. 150) grayish; costa not thickened at tip of first vein; last section of fourth vein a little bent before its middle; hind margin of wing scarcely indented at tip of fifth vein, with a slight sinus between the tips of fifth and sixth veins so as to form a broad but not conspicuous lobe at tip of sixth vein and the anal angle, which is prominent; wing of somewhat equal width.

Female.—Face wide, grayish; fore tarsi plain, a little longer than their tibiae, becoming black toward their tips, first joint nearly as long as the three following joints taken together, fifth joint a little longer than fourth; wings rather evenly rounded on the hind margin.

Described from many specimens. C. W. Metz took it at Sheridan, Wyoming, in July; C. F. Baker took it in Colorado; A. L. Melander took it at Kamiac Butte, Washington, and at Gardiner Valley, Montana, August 20, 1918.

Holotype and allotype in the United States National Museum taken in Colorado.

Type.—Male, Cat. No. 23041, U.S.N.M.

No. 151. DOLICHOPUS COMPLETUS, new species.

Male.—Length 5-6 mm.; of wing 5-5.5 mm. Face wide, a little narrowed below, yellowish gray, sometimes other yellow, more white below. Front green, dulled with gray pollen. First antennal joint yellow, sometimes a little brownish on upper edge; second and third joints black, the latter somewhat conical in outline, slightly longer than wide, obtusely pointed at tip. Lateral and inferior orbital cilia pale yellowish, about nine of the upper cilia on each side black.

Thorax bronze brown with more or less green reflections; dorsum dulled with thick yellowish gray pollen, which is always gray in the front and sometimes quite gray on the disk but usually decidedly yellowish; pleurae dulled with white pollen. Abdomen green with narrow black incisures; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black, its lamellae rather large, somewhat oval but narrowing into the stem, about twice as long as wide, white with a black border, which is wide on apical, narrow on upper margin, jagged and bristly on lower half of apical margin, fringed above with little black hairs, below with a few small brown hairs.

Fore coxae yellow, a little blackened at base, their anterior surface with little black hairs on apical two-thirds, which become minute and leave a nearly bare space below the black base. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter without cilia below, but with the little black hairs on their sides reaching the lower edge so as to leave scarcely a trace

of the usual glabrous line on lower edge. Posterior tibiae sometimes a little infuscated at tip, only a little thicker than the others, the two rows of large bristles on upper surface are placed so close together that the usual glabrous stripe between them can scarcely be traced. Fore tarsi (fig. 151a) one and a third times as long as their tibiae; second joint about three-fourths as long as first; first four joints vellow, third scarcely one-third as long as second, fourth a little more than half as long as third, scarcely as long as wide, a little compressed; fifth black, much compressed, about as long as second, not quite as wide near the tip as it is long, fringed above with little black hairs. Middle tarsi a little longer than their tibiae, black from the tip of the first joint, which has a large bristle above near apical fourth. Hind tarsi wholly black, sometimes the first joint is more dark reddish brown or even yellowish. Calypters and halteres vellow, the former with black cilia.

Wings (fig. 151) grayish, tinged with yellowish brown in front of third vein and along the posterior veins; costa scarcely enlarged at tip of first vein; last section of fourth vein a little bent before its middle; hind margin of wing slightly indented at tip of fifth vein, with a small sinus before and after the tip of sixth vein so as to leave a slight lobe at tip of sixth vein and at the anal angle, which is prominent; wing of somewhat equal width, still a little narrowed at root.

Female. - Face wide, covered with gray pollen; fore tarsi plain, a little longer than their tibiae, infuscated almost to their base, but scarcely black even at tip, first joint scarcely longer than the two following taken together, fifth a little longer and wider than fourth; middle tibiae with four bristles below, one pair at apical third, one bristle at basal third, and one halfway between these; wings more evenly rounded than in the male, a little narrowed at root, anal angle a little prominent.

Described from 7 males and 4 females, taken by J. M. Aldrich, at Mono Lake, California, July 21-23.

Type. - Male, Cat. No. 23042, U.S.N.M.

No. 152. DOLICHOPUS ÆRATUS, new species.

Male.—Length 5-6 mm.; of wing 4.75-5 mm. Face wide, a little narrowed below, yellowish gray. Front mostly coppery with grayish pollen. First antennal joint yellow, sometimes with a blackish line on upper edge; second and third joints black, third about as long as wide, rounded at tip. Lateral and inferior orbital cilia yellowish, about six of the upper cilia on each side black.

Thorax bronze brown with a little green along the edges of the dorsum, which has coppery reflections and is covered with thick brownish pollen; pleurae dulled with gravish white pollen. Abdomen green with more or less coppery reflections; the white pollen on its

sides abundant and extending upon the dorsum. Hypopygium black; its lamellae rather large, somewhat oval, about twice as long as wide, whitish with a black border, which is wide on apical, narrow on upper margin, jagged and bristly at apex, fringed above with little black hairs.

Fore coxae yellow, slightly blackened at extreme base, their anterior surface covered with conspicuous black hairs. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter without cilia below, but the black hairs on the sides reach the lower edge. Posterior tibiae a very little thickened, more so on apical half where the hairs on inner surface are longer and denser, sometimes a little darkened on inner side toward the tip. Fore tarsi (fig. 152a) one and a half times as long as the tibiae, first two joints of equal length and taken together about as long as the tibia; first three joints vellow, third scarcely one fourth as along as second, fourth half as long as third, slightly widened, as wide as long, slightly brownish; fifth joint black, four-fifths as long as first, much compressed, somewhat oval, nearly as wide as long, fringed above with little black hairs; pulvilli white, conspicuous. Middle tarsi one and a third times as long as their tibiae, infuscated from the tip of the first joint, which has a large bristle above at apical fourth. Hind tarsi wholly black, still the first joint sometimes a little reddish. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 152) grayish, slightly tinged with yellowish brown in front of third vein; costa without an enlargement at tip of first vein; last section of tourth vein a little bent just before its middle; hind margin of wing slightly indented at tip of fifth vein, with a slight sinus each side of the tip of sixth vein, so as to form a slight lobe at tip of sixth vein and at the anal angle, which is prominent; wings of rather parallel width.

Female.—Face wide with gray pollen; fore tarsi plain, a little longer than their tibiae, intuscated from the tip of the first joint, but the extreme base of the three following joints yellowish, first joint equal in length to the three following joints taken together, third and fifth of about equal length, fourth a little shorter, but as thick as the others. Wings evenly rounded on the hind margin; anal angle rounded but rather prominent.

Described from six males and one female. Three males and the female were taken in Colorado, by Baker; two males at Dinwiddie Creek, Wyoming, September 5, 1895 (Wheeler); and one male at Laramie, Wyoming, August, 1893. All were in the collection of J. M. Aldrich.

Type.—Male, Cat. No. 23043, U.S.N.M., from Colorado.

The males of æratus and procerus have the first two joints of the fore tarsi equal in length, but in procerus the third joint is three-

fourths as long as second and the wing has no sinus betweem the tip of sixth vein and the anal angle, while in xratus the third joint is only about one-fourth as long as second and there is quite a distinct sinus between the tip of sixth vein and the anal angle. Xratus agrees with completus in the form of the wing at the anal angle, but differs in having the first two joints of fore tarsi equal, while in completus the second is only three-fourths as long as first, the third is also longer in this, being half as long as second, while in xratus it is scarcely one-fourth as long as second. The female of xratus differs from that of completus in having the first joint of fore tarsi as long as the three following together, while in completus the first joint is scarcely as long as the two following together. The female of procerus differs from that of completus only in being more shining. It is also more shining than that of xratus.

No. 153. DOLICHOPUS SUFFLAVUS, new species.

Male.—Length 5 mm.; of wing the same. Face wide, a little narrowed below, yellow to grayish yellow. Front green, with bronze reflections. First antennal joint yellow; second and third joints black, the latter about as long as wide, somewhat orbicular in outline. Lateral and inferior orbital cilia pale yellow, about seven of the upper cilia on each side black.

Thorax dark green, usually with bronze reflections, which form two narrow vittae on the dorsum, the anterior portion of which is a little dulled with gray pollen; pleurae with grayish white pollen. Abdomen dark green with slight bronze reflections on the hind margins of the segments; the white pollen on its sides mostly confined to the lower edges. Hypopygium black; its lamellae rather large, somewhat oval, twice as long as wide, yellowish or yellowish brown, shading into a broad black border at apex, sometimes they are more whitish; they are jagged and bristly on apical margin, fringed above with little black hairs, below with pale hairs.

Fore coxae yellow, blackened a little at base, their anterior surface covered with black hairs, those along the outer edge unusually long. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter without cilia below, the black hairs on the sides reaching the lower edge. Posterior tibiae slightly thickened, the glabrous stripe on upper surface rather broad but somewhat broken by little hairs. Fore tarsi (fig. 153a) nearly one and a third times as long as their tibiae, first joint longer than the three following taken together, with a row of minute bristles below, second joint about one-third as long as first, third and fourth together about as long as second, slightly widened, fourth shorter than third, scarcely as long as wide; first three joints yellow, still sometimes quite infuscated, fourth more or less black; fifth joint deep black, much compressed, a little shorter

than first, not quite as wide as long, somewhat round in outline, fringed above with little black hairs. Middle tarsi one and a fourth times as long as their tibiae, black from the tip of the first joint, which has a large bristle above. Hind tarsi wholly black. Calypters and halteres yellow.

Wings (fig. 153) grayish; costa not enlarged at tip of first vein; last section of fourth vein moderately bent near its middle; hind margin of wing a little indented at tip of fifth vein; slightly widened at tip of sixth vein so as to form a slight lobe; anal angle prominent; wing of rather equal width.

Female.—Face grayish, wide; fore tarsi plain, a little longer than their tibiae, infuscated from the tip of the first joint, first joint about as long as the three following joints taken together, middle tarsi about as in the male, their basitarsi have the bristle at apical third; hind basitarsi yellowish on basal third or more; wings with the hind margin nearly evenly rounded; anal angle rounded.

Described from many males and females. J. M. Aldrich took it at Viola, Idaho, June 26; Moscow, Idaho, June 14-August 23; Juliaetta, Idaho, May 12; and Grangeville, Idaho, June 27. Baker took it in Colorado. A. L. Melander took it at Bovill, Idaho, June 17; Potlatch, Idaho, June 27; Troy, Idaho, June, 14; Pullman, Washington, June 6-July 11; Palouse, Washington; Union Flat, Washington, June 6; Three Forks, Montana, August 1; Helena, Montana, August 6; Yellowstone Park, Canyon Camp, August 12. W. M. Mann took it at Nigger Hill, Powell County, Montana, in July.

Type.—Male, Cat. No. 23044, U.S.N.M. from Moscow, Idaho.

No. 154. DOLICHOPUS COLORADENSIS Aldrich.

Dolichopus agilis Aldrich, Kansas Univ. Quart., vol. 2, p. 16, pl. 1, fig. 19; name changed on page 26.

The following is a copy of Aldrich's original description:

Antennae black, first joint yellow; cilia of inferior orbit pale, of tegulae black; legs yellow, hind tarsi wholly black.

Male.—Face yellowish gray; front shining green. Dorsum of thorax shining green; pleurae blackish, with gray dust. Abdomen shining green; hypopygium black, at base somewhat green or bronze. Lamellae light yellow, twice as long as wide, the black border wide at tip, which is a little jagged and has two or three crooked black bristles; upper margin smooth with short black hairs changing to yellow toward the base. Fore coxae yellow with minute black hairs in front; middle and hind coxae black, tipped with yellow. Femora and tibiae yellow, plain. Front tarsi [fig. 154] almost once and a half as long as the tibiae, first three joints slender, stalk like, yellow, second and third each more than half as long as the preceding; fourth very short, wider than long; fifth joint as long as the second, wide, black, with fringe of appressed black hairs above. Empodium a little enlarged, forming a snow-white plume reaching up half the width of the fifth joint, so the latter appears to have a white tip. Middle tarsi gently infuscated from the tip of the first joint. Wings with a grayish tint, the fourth vein running rather far forward toward its tip; costa not thickened.

Length 5 mm.; of wing 4.5 mm.; one male and two females. Colorado (U. K.)

At the last minute I have decided that a series described as new were really this species; the specimens were all from Colorado and the drawing was made from one of these specimens.

Type.—In the University of Kansas, from Colorado.

No. 155. DOLICHOPUS LOBATUS Loew.

Dolichopus lobatus Loew, Neue Beitr., vol. 8, 1861, p. 24; Mon. N. Amer. Dipt., pt. 2, 1864, p. 72.—Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 16, pl. 1, fig. 20.—Coquillett, Proc. Wash. Acad. Sci., vol. 2, 1900, p. 425.— MELANDER and BRUES, Biol. Bull., vol. 1, 1900, p. 148.—Johnson, Insects of New Jersey, 1909, p. 756.

Male.—Length 5.5-7 mm.; of wing 5-6 mm. Face rather wide, a little narrowed below, pale yellow, more white below. Front shining green with bronze reflections; first two antennal joints vellow; third black, somewhat oval, but little longer than wide; obtusely pointed at tip. Lateral and inferior orbital cilia vellowish, about six of the upper cilia on each side black.

Thorax green with bronze, sometimes blue, reflections; dorsum often with a median coppery vitta, covered with an almost invisible vellowish gray pollen; pleurae dulled with white pollen. Abdomen green with bronze, sometimes violet, reflections; the white pollen on its sides abundant, reaching upon the dorsum. Hypopygium black, its lamellae rather large, somewhat oval in outline, twice as long as wide. white with a wide black border on the apical margin, which is jagged and bristly on the lower half, fringed above with black hairs.

Fore coxae vellow, their anterior surface covered with delicate yellow hairs, sometimes with a few minute black ones on inner edge; middle and hind coxae vellow with their outer surface more or less black. Femora and tibiae vellow, middle and hind femora each with one preapical bristle, the latter without cilia below, but with a row of delicate little vellow hairs on the lower inner edge. Posterior tibiae thickened, especially in the middle, sometimes a little darkened on apical half of inner side; the glabrous stripe on upper surface broad but broken by little hairs. Fore tarsi (fig. 155a) one and a third times as long as their tibiae, first three joints slender, yellow, sometimes a little infuscated from the tip of the first joint, fourth and fifth joints black; first joint as long as the three following joints taken together, second two-thirds as long as first, third half as long as second, fourth half as long as third, about as wide as long; fifth much compressed, longer than second, somewhat oval, about two thirds as wide as long, fringed above with black hairs; middle tarsi a little longer than their tibiae, black from the tip of the first joint, which has a large bristle above at apical third; hind tarsi wholly black. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 155) grayish, sometimes tinged a little with yellowish brown along the front: costa scarcely enlarged at tip of first vein: last section of fourth vein a little bent near its middle; hind margin of wing a little indented at tip of fifth vein, deeply hollowed before the tip of sixth vein and again between the sixth vein and the ana angle, so as to form two prominent lobes, one at the tip of sixth vein and one at anal angle.

Female.—Face wide, silvery white; fore tarsi plain, infuscated from the tip of the first joint, which is about as long as the three following joints together; fifth longer than fourth; hairs on the anterior surface of the fore coxae yellow, as in the male; hind tibiae a little thicker than the others but not swollen in the middle as in the male; wings (fig. 155b) with hind margin rather evenly rounded. still with just a little lobe at tip of sixth vein.

Redescribed from many specimens from the following locations: Lafayette, Indiana, June 2–26; Brookings and Erwin, South Dakota (Aldrich), June; Agricultural College, Michigan; Milwaukee, Wisconsin, June 28 (Wheeler); Hagerman, Idaho, July 1 (Aldrich); Kamiac Butte, Washington (Melander); Chicago, Illinois, June 6; Colorado, Erie County, New York, June 9–24; Elba, New York, June 25; Olcott, New York, July 4; Dauphin, Manitoba, Canada, June 22; Ottawa, Canada, July 2. I have taken it in the following places in Ontario, Canada: Fort Erie, Ridgeway, Toronto, Bond Lake, Chatham, and Kearney, June 17–July 24.

Type locality.—English River, Canada. Aldrich reports it from South Dakota and Michigan; Coquillett from Kukak Bay, Alaska; Johnson, Insects of New Jersey, reports it from Delaware Water Gap, New Jersey, July 15.

Type.—In Museum of Comparative Zoology, Cambridge, Massachusetts.

No. 156. DOLICHOPUS OMNIVAGUS, new species.

Male.—Length 5.5-6.5 mm.; of wing, 5-5.5 mm. Face rather wide, golden yellow, a little more white below. Front green with bronze reflections. First antennal joint yellow, second partly, sometimes mostly, yellow, especially on inner side; third black, about as wide as long, somewhat triangular, pointed at tip. Lateral and inferior orbital cilia yellow, about six of the upper cilia on each side black.

Thorax green, usually with bronze reflections; pleurae dulled with white pollen. Abdomen green with bronze and blue reflections; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black; its lamellae large, about two and a half times as long as wide, somewhat elliptical, yellowish white with a rather wide black border on apical margin, which is jagged and bristly, fringed above with rather long brown hairs.

Fore coxae yellow, their anterior surface covered with little black and delicate yellow hairs; sometimes there are more yellow than

black hairs and at other times only a few yellow ones. Middle and hind coxae yellow, more or less blackened on outer surface. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter without cilia, but with a row of minute pale hairs on lower inner edge. Posterior tibiae thickened, slightly more so beyond the middle, often darkened on inner side at tip. Fore tarsi (fig. 156) one and a half times as long as their tibiae, first two joints nearly as long as the tibia, slender, a little infuscated, second joint nearly as long as the first, third and fourth infuscated, third onethird as long as second, a little widened at tip, fourth a little more than half as long as third, as wide as long; fifth joint black, much compressed, nearly as wide as long, three-fourths as long as second, somewhat round in outline with a rounded emargination on apical margin below its middle, forming two lobes, the upper of which is much the largest. Middle tarsi one and a fourth times as long as their tibiae, black from the tip of the first joint, which has a large bristle above near apical third. Calypters and halteres yellow, the former with black cilia.

Wings gray, tinged with yellowish brown on front half; costa distinctly enlarged at tip of first vein, tapering to its tip; last section of fourth vein a little bent before its middle; hind margin of wing only slightly indented at tip of fifth vein, with a very prominent lobe at tip of sixth vein and another equally prominent at anal angle.

Female.—Face wide, gray; first antennal joint yellow, second and third black; fore tarsi plain, first joint slightly longer than the three following joints together, second scarcely half as long as first, fifth as long as third, fourth distinctly shorter, fore coxae with black hairs on the lower half of anterior surface; costa without enlargement, hind margin of wing without any trace of a lobe, anal angle prominent.

Described from 18 males and 1 female. Eight males were taken at Battle Creek, Michigan (Aldrich), 1 at Elm Grove, Wisconsin, July 4; 1 at Elba, New York, June 25; 2 at East Aurora, New York, June 15; 3, and 1 female at Three Forks, Montana, August, 1; 2 at Kearney, Ontario, July 7 and 28; 1 at Kukak Bay, Alaska, July 4, Type.—Male, Cat. No. 23045, U.S.N.M., from East Aurora, New York.

Allotype in the collection of A. L. Melander taken at Three Forks, Montana.

No. 157. DOLICHOPUS AMPHERICUS Melander and Brues.

Dolichopus amphericus MELANDER and BRUES, Biol. Bull., vol. 1, 1900, p. 146, fig. Male.—Length 6 mm.; of wing 4.5 mm. Face wide, dark golden yellow. Front green. First antennal joint wholly yellow; second joint yellow on inner side, black on outer; third wholly black, about as long as wide, rounded at tip. Lateral and inferior orbital cilia yellowish, about four of the upper cilia on each side black.

Thorax green; dorsum dulled with gray pollen and with more or less coppery reflections, which forms somewhat of a median vitta; on each side at the suture is a bronze brown spot; pleurae dulled with white pollen. Abdomen green with coppery reflections, especially toward its tip; the white pollen on its sides abundant. Hypopygium black; its lamellae large, somewhat elliptical, but narrowed into the stem, about two and a half times as long as wide, being as long as the second joint of the hind tarsi, yellowish with rather wide black border on apical, and narrow border on upper margin, jagged and bristly at apex, closely fringed above with little black hairs.

Fore coxae wholly yellow, their anterior surface covered with little yellow hairs, usually with a few minute black ones on inner edge; middle and hind coxae black with yellow tips, the latter yellow on inner Femora and tibiae yellow; middle and hind femora each with one preapical bristle, the latter without cilia below, but with a row of delicate little yellow hairs on the lower inner edge, on the outer surface the little black hairs descend nearly or quite to the lower edge. terior tibiae moderately thickened; the usual glabrous stripe on upper surface is broken up by the irregular placing of the large bristles and numerous little black hairs; fore tarsi (fig. 157) nearly one and a half times as long as their tibiae; the two first joints slender, thin, glabrous on the sides, with minute black hairs on upper and lower edges, taken together nearly as long as the tibia; second two-thirds as long as first, third short, about one-third as long as second; first three joints yellow, third sometimes with the tip black, the black more extensive on outer surface, which is sometimes mostly infuscated; it is slightly widened at tip; fourth joint black, about as wide as long, closely fringed above with black hairs; fifth joint black, compressed, about as long as third and fourth together, somewhat oval, but narrowed toward the base, fringed above with black hairs; last three joints taken together about as long as first, forming a somewhat elongate triangular tip to the tarsi, but broadly rounded at tip. Middle tarsi about one and a fourth times as long as their tibiae, blackened from the tip of the first joint, which has a large bristle above. Hind tarsi black, sometimes a little yellowish at base. Calypters and halteres yellow, the former with black cilia.

Wings grayish, tinged with yellowish in front; costa scarcely enlarged at tip of first vein; last section of fourth vein a little bent beyond its basal third; hind margin of wing only a little indented at tip of fifth vein, with a sinus between the tips of fifth and sixth veins, so as to form a slight lobe at tip of sixth vein, from which point the

hind margin recedes to the anal angle, which is still rather prominent but narrow.

Female.—Face wide, yellowish gray; fore tarsi plain, only a little longer than their tibiae, yellow, slightly darkened from tip of first joint, still only blackened from the tip of third joint; wings nearly as in the male, except that there is no sinus on hind margin, but they recede from the tip of the sixth vein to the anal angle as in the male, so as to give a flattened appearance to the anal angle.

Redescribed from the type specimens in the American Museum, in New York City; they were taken in Price County, Wisconsin.

The following notes may help the student to separate the preceding group of species, some of which might be found difficult to determine with certainty: There are 10 species (lobatus, omnivagus, amphericus, s peciosus, procerus, æratus, walkeri, coloradensis, sufflavus, completus), which resemble each other in having the first antennal joint yellow or mostly yellow, third wholly black; in the general form of the fore tarsi; in having the hind tibiae wholly yellow or nearly so, and the hind tarsi wholly black.

The first three of these have the second antennal joint yellow, at least on the inner side; amphericus has only the inner side of the second antennal joint yellow, it also differs from the other two in having the fifth joint of fore tarsi much smaller and not so round in outline; lobatus has the apical edge of the fifth joint of fore tarsi evenly rounded, while in omnivagus there is a conspicuous emargination near the lower corner. In procerus and æratus the first two joints of fore tarsi are of about equal length; in walkeri the second is three-fourths as long as first, in completus it is two-thirds as long, and in coloradensis it is more than half as long as first; in speciosus and sufflavus the second is distinctly less than half as long as first. In procerus the third joint of the fore tarsi is a little more than half as long as the second, while in æratus it is only about one-fourth as long as second; completus differs from coloradensis in having the third joint less than half as long as second, while in the latter it is more than half as long as second. In speciosus the second joint is about equal to the third in length, while in sufflavus the third is distinctly shorter than second. There are other points of difference but these should make the determination of these species sure.

No. 158. DOLICHOPUS AFFLICTUS Osten Sacken.

Hygroceleuthus afflictus OSTEN SACKEN, Western Dipters, 1877, p. 313.—WHEELER, Proc. Calif. Acad. Sci., vol. 2, 1899, p. 3.—Melander and Brues, Biol. Bull., vol. 1, 1900, p. 132.

Male.—Length 5-6 mm.; of wing 5-5.8 mm. Face wide, white. Front shining green. Antennae black; first joint rather long, yellow on lower half; with stiff black hairs above; third joint about as long as wide, pointed at tip. Lateral and inferior orbital cilia vellowish white, the black cilia not quite reaching down to the middle of the eye.

Thorax green with considerable gray pollen; pleurae dulled with white pollen. Abdomen green with coppery reflections; the white pollen on its sides abundant and extending upon the dorsum; the second segment has a bunch of long yellow hairs on each side, the tips of these hairs reach upon the fourth segment; the third segment also has a similar bunch of yellow hair, but it is much smaller and shorter. Hypopygium black; its lamellae (fig. 158a) of moderate size, whitish with a narrow black border on apical and upper margins, jagged and bristly at apex, fringed above with delicate white hairs.

Fore coxae yellow with a black or green streak on the outer posterior edge, inner edge of anterior surface with little black hairs. Middle and hind coxae black with yellow tips. Middle femora with one preapical bristle; hind ones with a row of bristles of increasing length, ending in the usual preapical bristle, without cilia below. Posterior tibiae thickened, a little compressed, with a shallow groove on each side, that on the inner side glabrous. Fore and middle tarsi stout, scarcely as long as their tibiae, infuscated from the tip of the first joint, still the joints sometimes a little yellow at base. Hind tarsi black from the tip of the first joint. Calypters, their cilia and the halteres yellow.

Wings (fig. 158) grayish; costa with an elongated enlargement at tip of first vein; last section of fourth vein rather sharply bent before its middle; hind margin of wing deeply indented at tip of fifth vein with a very slight sinus at tip of sixth vein; anal angle of wing prominent.

Female.—Face but little wider than that of the male; antennae slightly shorter; thorax, legs, feet, and wings about as in the male, except that the costa is not enlarged at tip of first vein; there are no tufts of yellow hair on the sides of the second and third abdominal segments.

Redescribed from many males and females. J. M. Aldrich has specimens from Brigham, Utah, July 4, 1911, taken on parsnip flowers; Monterey County, California, July 15 (Wheeler); Santa Clara County, California (Baker); Stanford University, California, Oct.; Socorro, New Mexico (S. W. Williston). I took it at Palo Alto, California, June 3; Berkeley, California, Oct. A. L. Melander took it at Stanford, California, June 30; Pullman, Washington, June 30. F. E. Snow took it in Cochise County, Arizona, Aug., at 3,750 feet elevation.

Type locality.—San Rafael, Marin County, California. Wheeler reports it from Arizona; Melander and Brues from Wyoming and Arizona.

Type.—In Museum of Comparative Zoology, Cambridge, Massachusetts.

No. 159. DOLICHOPUS CRENATUS Osten Sacken.

Hygroceleuthus crenatus Osten Sacken, Western Diptera, 1877, p. 312.-ALDRCH, Kansas Univ. Quart., 1893, vol. 2, p. 24, pl. 1, figs. 27, 27a; American Naturalist, 1894, p. 35 (courtship).—Wheeler, Proc. Calif. Acad. Sci., vol. 2, 1899, p. 3, pl. 1, fig. 4.—Melander and Brues, Biol. Bull. vol. 1, 1900, p. 131, figs.

Male.—Length 5-6 mm.; of wing 4.5-5 mm. Face wide, of nearly equal width, silvery white; front shining green. Antennae (fig. 159a) black; first and second joints vellow on lower half, with a large smooth yellow protuberance on inner side; first joint very long and with stiff, long black hair; second and third of nearly equal length, taken together about as long as first; third scarcely longer than wide, pointed at tip; arista thick, clothed with long dense pubescence. Lateral and inferior orbital cilia yellowish, the lowest ones deeper yellow and slightly flattened; the black cilia descend below the upper third of the eve.

Thorax green with coppery reflections, which sometimes cover most of the dorsum. Abdomen green, usually with coppery reflections, its sides with white pollen. Hypopygium black; its lamellae of moderate size, oval, with a narrow black border on the apical margin: apex jagged and bristly, fringed above with black hairs, sometimes a few near the base yellowish.

Fore coxae yellow, with a green stripe on outer edge of its posterior side, their anterior surface with minute delicate white hairs and a few black ones along inner edge. Middle and hind coxae black with vellow tips; the trochanters usually with a brown spot. Femora and tibiae yellow. Middle femora each with one preapical bristle; hind pair with a row of bristles of increasing length, ending in the usual preapical bristle, without cilia below. Posterior tibiae a little thickened and compressed, with a shallow glabrous groove on inner side, the glabrous stripe on upper surface distinct, but broken by a few hairs. Fore and middle tarsi about as long as their tibiae, infuscated from the tip of the first joint: still the base of some of the other joints vellowish; first joint of fore tarsi as long as the remaining four taken together, fourth the shortest. Calypters, their cilia, and the halteres yellow.

Wings (fig. 159) grayish; broad, narrowed from the middle to the anal angle, which is still prominent; costa thick with a rather long knotlike enlargement at tip of first vein; last section of fourth vein considerably bent a little before its middle; hind margin of wing deeply indented at tip of fifth vein, which is bent backward near the middle of its last section almost at a right angle.

Female.—Face wide, grayish white; arista nearly as thick as in the male, but the antennae smaller; wings of nearly normal shape, without an enlargement of the costa, rather evenly rounded on hind margin, indented at tip of fifth vein; cilia of the calypters usually 187329--21----15

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black. Middle tibiae with two bristles below, their basitarsi without a bristle above.

Redescribed from many males and females. J. M. Aldrich has specimens from Moscow, Idaho, Aug. 23, 24; Potlatch, Idaho, June 20; Viola and Juliaetta, Idaho; Corvallis, Oregon, Aug. 15; Beaver Creek, Newport, Oregon, Aug. 13. I have specimens from Berkeley, California, Sept. 16; Samoa Beach, Humboldt County, California, June 18. A. L. Melander has taken specimens at Pullman, Washington, June—Sept.; Tacoma, Washington, Aug. 27; Chehalis, Washington, Aug. 25; others are from Cochise County, Arizona, Aug. 3 (3,750 feet elevation); Claton, British Columbia, Aug. 9; Abbotsford, British Columbia, Aug. 9.

Type locality.—Sonoma County, California. Aldrich reports it from California and Washington; Wheeler from Idaho, Washington, Wyoming; Melander and Brues from California, Washington, Wyoming, Idaho, and Vancouver Island.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

No. 160. DOLICHOPUS CONSANGUINEUS Wheeler.

Hygroceleuthus consanguineus Wheeler, Proc. Calif. Acad. Sci., vol. 2, 1899, p. 5, pl. 1, fig. 5-7.—Melander and Brues, Biol. Bull., vol. 1, p. 131, figs.

Male.—Length 5.5-7 mm.; of wing 5-6 mm. Face wide, pale yellowish white, in some specimens the face has one or two ocher yellow longitudinal bands which are visible in certain lights only. Front dark shining green. Antennae black, with a large, smooth, yellow protuberance on inner side of first joint and a small one on second joint; first joint long with bristly hairs; third joint a little longer than wide, conical in outline; arista thick and densely pubescent. Orbital cilia black with 4-10 orange yellow cilia, from near the middle of the eye downward the lower cilia are much flattened.

Thorax dark shining green, with more or less bronze or coppery reflections; pleurae dulled with white pollen. Abdomen dark shining green with coppery reflections; and white pollen on its sides. Hypopygium mostly metallic green, like the abdomen; its lamellae of moderate size, oval, whitish, sometimes tinged with brown, with narrow black border along the apical edge, a little jagged and bristly at apex, fringed above with black hairs.

Fore coxae yellow with a broad green stripe on outer posterior edge, their anterior surface covered with black hairs, which are sometimes quite long. Middle and hind coxae black with narrow yellow tips. Femora and tibiae yellow. Middle femora with one preapical bristle; posterior pair with a row of bristles of increasing length, which ends in the usual preapical bristle. Posterior tibiae a little thickened and compressed, with a glabrous groove on inner surface; the usual glabrous stripe on upper surface quite distinct. Fore tarsi

about as long as their tibiae, infuscated from the tip of the first joint, still the second and third joints sometimes yellowish at base; first joint about as long as the remaining four together; fourth joint shortest: middle tarsi scarcely as long as their tibiae, colored like the fore tarsi. Calypters and halteres yellow, the cilia of the former black.

Wings (fig. 160) strongly tinged with brown, sometimes more yellowish brown in front of second vein; costa with a knot-like enlargement at tip of first vein; last section of fourth vein sharply bent before its basal third, sometimes with a stump-vein at the posterior angle of this bend (this stump is present in most of the females I have seen); hind margin of wing deeply notched at tip of fifth vein, which is bent at a right angle near the middle between the cross-vein and the wing margin; wings broad, widest near the crossvein, narrowing to the anal angle.

Female.—Face wide, usually dark gray, sometimes more whitish or yellowish, antennae smaller than those of the male; fore coxae with rather long and conspicuous black hairs on the anterior surface; hind tibiae normal; orbital cilia about as in the male, except that they are scarcely flattened at all; wings (fig. 160a) of nearly normal shape, rather broad and with the hind margin rather evenly rounded, the anal angle not at all prominent, deeply notched at tip of fifth vein, the bend in fourth vein more distant from the cross-vein than in the male, being about as far from it as the cross-vein is long.

Redescribed from 5 males and 8 females. J. M. Aldrich has specimens from Pine Lake, southern California, taken by Johnson; Pacific Grove, California, May 9, (Aldrich); Vollmer, Idaho, September 26, (Aldrich); Colorado, (Baker); E. P. Van Duzee took it at Tallac Lake, Tahoe, California, July 17, 1915.

Type locality.—Monterey, California. Melander and Brues report it from California.

No. 161. DOLICHOPUS BRUESI, new name.

Hygroceleuthus propinguus Melander and Brues, Biol. Bull., vol. 1, p. 131 (preoccupied).

The following is a copy of the original description of this form as they compared it with consanguineus Wheeler and which still covers most of the points of difference between them:

Darker, all coxae piceous; femora piceous beneath near the base. Postocular cilia black, none of the orange colored cilis typical of consanguineus present, not so many of the infraorbital cilia flattened, lamellae of hypopygium darker.

All the above characters are more or less conspicuous in the specimens I have seen, but some have the fore coxae quite yellow on the anterior surface, others have them almost wholly greenish. Besides the characters given above I find in the specimens before me that the wings in both male and female are a little wider at the tip of sixth. vein, making the anal angle a very little fuller, in the male making the

sixth vein run a little more parallel with the margin of the wing; the bend in last section of fourth vein is also a very little farther from the cross-vein in *bruesi* (fig. 161) in both sexes, in the male it is at basal third not "before basal third," in the female of this form it is very near the middle of the last section, while in the female of consanguineus it is very near basal third.

The specimens before me were taken by Dr. J. M. Aldrich at Roche Harbor, Washington, July 3, 1905; Friday Harbor, Washington, July 5, 1905; and Keyport, Washington, August 7, 1905, and two specimens taken by Prof. A. L. Melander, one at San Francisco, California, Aug. 15; the other at Canyon Camp, Yellowstone Park, August 12, 1918.

As all of these specimens agree in the wing characters given above, as well as those given by Melander and Brues, I am inclined to give this form rank as a distinct species.

Zetterstedt described a species from Europe under the name of propinquus which still goes under that name, I therefore propose the name of bruesi for the present species.

Type locality.—Vancouver Island.

Type.—In American Museum of Natural History, New York City.

No. 162, DOLICHOPUS AURIFEX, new species.

Male.—Length, 5.5-6.5 mm.; of wing 5-6 mm. Face wide, whitish, tinged with yellow. Front green with bronze and coppery reflections. Antennae black; first joint long with long stiff hair and a large protuberance on inner-side, which is largely yellow; second joint wholly black, or with just a trace of yellow on inner side; third wholly black, pointed at tip. Orbital cilia black above down to the middle of the eye, below this pale yellow, a little darker below, sometimes there are one or two black bristles next to the proboscis, none of the cilia flattened, although the lower ones are rather stout.

Thorax green with bronze reflections, which sometimes form two narrow vittae on the dorsum, anterior slope of the dorsum with two patches of white pollen and these patches clothed with black hairs, as in the allied species. Abdomen green with coppery reflections, and with white pollen on its sides. Hypopygium black, more or less greenish; its lamellae (fig. 162a) of moderate size, brownish with broad black apical border which shades into the brown of the disk, somewhat oval, jagged at tip, fringed all around with blackish hairs which are stoutest at apex, their disk clothed with minute hairs which are pale near the base, black at their tips.

Fore coxae yellow, more or less tinged with brown on outer side and with a green stripe on outer posterior edge. Middle and hind coxae black with narrow yellow tips. Trochanters with brown dots, posterior ones brown. Femora and tibiae yellow. Middle and hind

femora each with a row of bristles of increasing size, ending in the usual preapical bristle, the latter almost bare below. Posterior tibiae a very little thickened and compressed, with a shallow glabrous groove on inner surface. Fore and middle tarsi about as long as their tibiae: first joint a little shorter than the remaining four taken together, fourth joint scarcely shorter than the fifth. Hind tarsi a little longer than their tibiae. All tarsi black from the tip of the first joint. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 162) grayish, brownish in front of third vein; costa stout with a knot-like enlargement at tip of first vein; last section of fourth vein rather sharply bent a little beyond its basal third; hind margin of wing notched at tip of fifth vein, which is sharply bent toward the wing margin; anal angle rounded; wing of normal shape, evenly rounded behind.

Female.—Face wider and antennae smaller than in the male; middle femora with one preapical bristle; wing as in the male, except that the costa is not enlarged at tip of first vein. Middle tibiae with two large bristles below, their basitarsi without a bristle above.

Described from 6 males and 4 females taken at Newport, Oregon, August 13, 1902, at seepage just above the sea beach, by J. M. Aldrich. Type.—Male, Cat. No. 23046, U.S.N.M.

No. 163, DOLICHOPUS IDAHOENSIS Aldrich.

Hygroceleuthus idahoensis Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 154.-MELANDER and BRUES, Biol. Bull., vol. 1, 1900, p. 133, figs.

Male.—Length 5-5.2 mm.; of wing 4.8-5 mm. Face rather wide, long, reaching the lower corner of the eye, silvery white; the vellow ground color shows through on the lower part, the ground color is probably more brown above. Front shining green. Antennae black; first joint of normal size, first and second yellow below; third joint about as long as wide, obtusely pointed at tip. Lateral and inferior orbital cilia silvery white, becoming flattened below, about ten of the upper cilia on each side black.

Thorax shining green, but slightly dulled with white pollen, sometimes with bronze reflections; pleurae with a little more white pollen than the dorsum. Abdomen green with coppery reflections on the hind margins of the segments, and large spots of white pollen on its sides. Hypopygium black, with green reflections; its lamellae of moderate size, somewhat oval, white with narrow black border on apical and upper margins, a little jagged and bristly at apex, fringed above with little black hairs.

Fore coxae yellow with a green stripe on outer posterior edge, anterior surface covered with silvery pollen and very minute white hairs, there are some little black hairs along inner edge. Middle and hind coxae black with yellow tips. Hind trochanters brown, the four anterior ones with a brown spot. Femora and tibiae yellow. Middle femora with one preapical bristle, the hind pair with a row of bristles of increasing size, ending in the usual preapical bristle, with out cilia below. Posterior tibiae thickened and a little compressed, with a glabrous groove on inner side, the glabrous stripe on upper surface narrow but distinct. Fore tarsi about as long, middle ones scarcely as long as their tibiae, infuscated from the tip of the first joint, still the second joint often yellow at base; first joint of fore tarsi a little shorter than the remaining four taken together, the fourth slightly the shortest of all. Hind tarsi black from apical third of first joint. Calypters, their cilia and the halteres yellow.

Wings (fig. 168) grayish, sometimes narrowly a little brownish along the cross-vein; costa thickened at tip of first vein for a distance equal to one and one fourth times the length of the cross-vein, this thickening is truncate and provided with a little spur at apex; last section of fourth vein sharply bent before its middle; hind margin of wing notched at tip of fifth vein; and with a slight sinus at tip of sixth vein; anal angle rounded, but rather prominent.

Female.—Face wide, silvery; fore coxae clothed on their anterior surface with stiff black hairs; wings as in the male, except that there is scarcely a trace of the sinus at tip of sixth vein and the costa is not enlarged at tip of first vein.

Redescribed from 16 males and 8 females, which includes 10 type specimens; the 10 types are from Moscow, Idaho; the others were taken at Moscow, Idaho, September 12, 1908; Stanford University, California, October 7, 1905; these were taken by J. M. Aldrich. Baker took it in Santa Clara County, California, and in Colorado. S. J. Hunter at Rock River, Wyoming, July, 1913.

Types.—In collection of J. M. Aldrich.

No. 164. DOLICHOPUS CAVATUS, new species.

Male.—Length 5 mm.; of wing 4-4.5 mm. Face moderately wide, silvery white, tinged with yellow below the antennae. Front green with bronze reflections. Antennae black; first and second joints yellow below, first of normal size; third somewhat orbicular in outline, scarcely pointed at tip. Lateral and inferior orbital cilia white, the lower ones silvery and flattened, about fourteen of the upper cilia on each side black.

Thorax green with bronze reflections, and usually with a coppery spot on each side of the dorsum, which is dulled a little with yellowish pollen; pleurae dulled with white pollen. Abdomen green with coppery reflections; the white pollen on its sides is not conspicuous and has a yellowish tint. Hypopygium black; its lamellae (fig. 164a) of moderate size, somewhat oval in outline, but with edges

somewhat parallel and rising rather abruptly from the stem at base, nearly one and a half times as long as wide, white with a rather narrow black border on apical margin, which is jagged and bristly. Fore coxae yellow with a greenish stripe on the outer posterior edge, their anterior surface covered with silvery pollen and very minute white hairs, with some black ones along inner side; there are also some black bristly hairs at base. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle femora with one preapical bristle; hind pair with a row of bristles of increasing length, ending in the usual preapical bristles. Posterior tibiae thickened and compressed, their inner surface with a glabrous groove, this groove is not exactly glabrous but is covered with very minute hairs; the lower posterior bristle at tip of middle tibiae is long and very slender and of a pale yellow color. Fore and middle tarsi about as long as their tibiae, black from the tip of the first joint; anterior pair with the first joint nearly as long as the remaining four taken together, third and fifth of equal length, fourth a little shorter. Hind tarsi black from the middle of the first joint, a little longer than their tibiae. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 164) grayish, slightly tinged with brown along the front and on the cross-vein; costa black and rather thick from the tip of the first vein, where there is a rather long knot-like enlargement; last section of fourth vein bent a little before its middle; hind margin of wing indented at tip of fifth vein, rather evenly rounded; anal angle rounded, but rather prominent.

Described from 4 males. Two were taken at Hood River, Oregon (Cole); 1 at Corvallis, Oregon; 1 at Sobre Vista, Sonoma County, California, June 29, 1910.

Tune.-Male. Cat. No. 23047, U.S.N.M.

No. 165. DOLICHOPUS PENICILLATUS, new name.

Hygroceléuthus ciliatus Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 25, pl. 1, fig. 28 (preoccupied).—Wheeler, Proc. Calif. Acad. Sci., vol. 2, 1899, p. 3.-Melander and Brues, Biol. Bull., vol. 1, 1900, p. 133, figs.

Male.—Length, 4-5.5 mm.; of wing, 4.5-4.75 mm. Face rather wide and long, silvery below, strongly tinged with yellow above. Front shining green, with a trace of vellowish pollen on its sides. Antennae black; first joint yellow below, as long or longer than third joint; second joint with a yellow spot at base; third joint a little longer than wide, obtusely pointed at tip. Upper third of the orbital cilia black, lower two-thirds pale yellow.

Thorax green with bronze reflections, somewhat dulled with yellowish gray pollen; pleurae dulled with white pollen. Abdomen green with bronze reflections; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black with green

reflections; its lamellae moderately large, somewhat subquadrate, but rounded at tip, nearly one and a half times as long as wide, yellowish white, with an apical black border, which is jagged and bristly, fringed above with hairs which are black on outer portion, white at base.

Fore coxae yellow with a green stripe on outer posterior edge, anterior surface clothed with delicate little white hairs; there are only a few little black hairs at extreme base of inner edge. Middle and hind coxae black with yellow tips. Femora and tibiae vellow. Middle and hind femora each with one preapical bristle, the latter nearly glabrous below. Posterior tibiae slightly thickened, usually blackish at tip for nearly one-fifth their length; the glabrous stripe on upper surface distinct and another glabrous line just inside of the inner row of large bristles. Middle tibiae with a row of three large bristles below, their basitarsi without a bristle above. Fore tarsi scarcely longer than their tibiae, black from the tip of the first joint, . which is about as long as the three following joints together; fourth and fifth joints of about equal length. Middle tarsi a little shorter than their tibiae, black from the tip of the joint. Hind tarsi about one and a fourth times as long as their tibiae, deep black from the tip of the first joint, first joint yellow at base for about half its length, the black not sharply limited. Calypters and halteres yellow, the former with very long, dense, deep black cilia.

Wings (fig. 165) grayish, usually darker in front of third vein; costa scarcely enlarged at tip of fifth vein, still when viewed from in front there is a cylindrical thickening which begins before the tip of fifth vein and ends abruptly a short distance beyond the tip; it is not conspicuous; last section of fourth vein bent before the middle; third vein bent backward at tip; hind margin of wing indented at tip of fifth vein; anal angle prominent but rounded; costa and veins yellowish brown, the thickening of the costa blackish.

Female.—Face a little wider, shorter and more gray than in the male; antennae a little smaller; pollen of the dorsum of the thorax more gray; costa not at all enlarged at tip of first vein; cilia of the calypteres about as in the male.

Redescribed from about 25 specimens. J. M. Aldrich took it at Wells, Nevada, July 12, 1911; and in South Dakota. E. P. Van Duzee took it at San Diego, California, October 18, 1913. A. L. Melander took it at Yellowstone Park, Upper Geyser Basin, August 7, 1918; Moscow Mountain, Idaho, September 16, 1917; and at Gardiner, Montana, August 17, 1918.

Type.—In collection of J. M. Aldrich, from Custer, South Dakota.

No. 166. DOLICHOPUS MISELLUS Melander.

Dichopus misellus MELANDER, Canadian Entomologist, vol. 32, p. 136, fig. 11.

Male.—Length 4.5 mm.; of wing 3.5 mm. Face of moderate width, yellow; front purple, or perhaps blackish with reddish reflections. First antennal joint not unusually long, yellow below, black on upper half, second and third joint black (the second may be a little yellow below, but I can not be sure); third joint a little longer than wide. Lower orbital cilia yellowish white.

Thorax and abdomen green, the latter with coppery reflections. Hypopygium black; its lamellae (fig. 166) of moderate size, somewhat oval, or perhaps more subquadrate in outline, yellowish white, with narrow black border at apex, which is jagged and bristly.

Fore coxae yellow with black or greenish stripe on the posterior edge of outer side, anterior surface apparently nearly bare, with five or six black hairs at upper inner corner, hind femora with one preapical bristle. Hind tibiae very slightly darkened at tip. Fore tarsi a little longer than their tibiae, black from the tip of the first joint, which is a little longer than the two following joints taken together, but not as long as the three following joints together; third and fifth joints of about equal length, fourth a little shorter. Calypters and halteres yellow, the former with long black cilia, which are not very numerous in the type.

Wings without what could be called an enlargement of the costa, but the costa with a very slight cylindrical thickening, which begins before the tip of the first vein and ends abruptly a short distance beyond the tip of that vein, this thickening is small and would not be so plainly seen if it were not blackish at tip and the costa more yellowish just beyond it.

Redescribed from the single type specimen in the American Museum in New York City.

This type specimen is in very poor condition (apparently always was), so it is difficult to decide with certainty whether this is *ciliatus* Aldrich or not, so I am letting the species stand for the present, and will add to my description of the type specimen that I saw the following points taken from original description:

Antennae lengthened, the joints subequal in length, first joint reddish below. Vertex violaceous with a cupreous tinge. Anterior face of front coxae dark yellow, sharply limited, without the usual coating of black hairs, but with a few pale ones. Hind tibiae with an elongate apical "dimple" and a narrow glabrous streak on the posterior face. Wings with the fourth vein obtusely but sharply bent, cross-vein distant less than twice its length from the tip of fifth vein.

Type location.—Little Wind River, Wyoming, September 2, 1895; and Natrona County, Wyoming, August 31, 1895, taken by Dr. W. M. Wheeler.

The only characters to separate this from *ciliatus*, as far as I can make out, are the violet front, the glabrous streak on posterior face, and possibly the less infuscated tip to the hind tibiae. The cilia of the calypters may be less dense and shorter, but I can not tell from the type.

The preceding group of seven species, although differing widely in some cases, have several striking characters in common. forms are idahoensis Aldrich; cavatus, new species; afflictus Osten Sacken; crenatus Osten Sacken; aurifex, new species; consanguineus Wheeler, and bruesi Van Duzee. The characters which these have in common are: Fore coxae yellow, with a peculiar black or green stripe on outer edge of the posterior surface, which reaches nearly their entire length, and is rather wide above, tapering to a point below, rarely the green is more extensive. Fore tarsi plain, about as long as their tibia, with the first joint nearly as long as the remaining four joints taken together; fourth joint slightly shorter than any of the others; fore tarsi infuscated from the tip of the first joint. Fore and middle trochanters with a brown dot, hind ones wholly brown. Hind femora without cilia below, but with a row of bristles of increasing length, ending in the usual preapical bristle. Middle tibiae with two large bristles below, their basitarsi without a bristle above. Hind tibiae a little thickened and compressed and with a shallow groove on inner surface, which appears to be glabrous. Wings with the costa more or less thickened at tip of first vein.

Of the characters that separate the species the most striking is the form of antennae. In all but the two first the first joint is long and furnished with long stiff hairs or bristles, being typical of the group which was included in the genus Hygroceleuthus; the first three have the antennae of the usual form, typical of the genus Dolichopus as it used to be restricted; of the two first cavatus has the cilia of the calypters black, while in idahoensis they are pale. Afflictus is easily separated from the remaining five species by the tufts of long yellow hair on the sides of the second abdominal segment. Of the remaining four forms the cilia of the calypters are pale in the male of crenatus, black in the others. Of these three species bruesi has the orbital cilia wholly black; in consanguineus there are from four to ten orange-colored cilia on the side with black cilia above and below; while in aurifex the lower orbital cilia are pale yellow. The form of the wings also furnish good characters for separating these species.

No. 167. DOLICHOPUS CHRYSOSTOMA Loew.

Dolichopus chrysostoma Loew, Mon. N. Amer. Dipt., pt. 2, 1864, p. 67.

Male.—Length 3-4 mm.: of wing 3.5 mm. Face narrow, vellowish white, in the type darker, almost golden yellow. Front shining green. Antennae (fig. 167) wholly black, third joint about twice as long as wide, with an acute point at tip, arista inserted at middle of third joint. Lower orbital cilia pale, a few of the upper cilia black.

Thorax green with a coppery spot on each side of the dorsum in front of the transverse suture; front slope of the dorsum with a little white pollen. Abdomen dark green or blackish green, with coppery reflections. Hypopygium black; its lamellae of moderate size, somewhat orbicular in outline, or perhaps they might be called triangular with rounded apex; whitish with wide black border on the margin of their apical half, a little jagged and bristly at apex.

Fore coxae yellow, a little infuscated at extreme base, with minute black hairs on the anterior surface. Middle and hind coxae black with vellow tips, posterior pair mostly vellow except on outer surface. Femora and tibiae yellow. Middle and hind femora with one preapical bristle, the latter without cilia below, still with a fringe of minute vellow hairs on lower inner edge. Posterior tibiae with the usual glabrous stripe on upper surface very indistinct and narrow. Fore tarsi scarely one and a fourth times as long as their tibiae, yellow, only a little infuscated at tip. Middle tarsi fully one and a fourth times as long as their tibiae; first two joints yellowish with brown tips, remaining joints dark brown, still the base of the third paler. Hind tarsi blackish from the tip of the first joint, which is mostly pale yellow, still the base of the second is quite yellowish. Calypters and halteres yellow, the former with black cilia.

Wings gravish; of rather equal width; costa scarcely enlarged at tip of first vein; last section of fourth vein a little bent at a point slightly beyond its basal third; tips of third and fourth veins rather widely separated, still the third bent backward; hind margin of wing not indented at tip of fifth vein; anal angle prominent.

Redescribed from the type specimen, and 1 male in the United States National Museum collection, taken at Beverly, Massachusetts, July 21, 1869.

Type locality.—Washington, District of Columbia.

No. 168. DOLICHOPUS PARVICORNIS, new species.

Male.—Length 3 mm.; of wing 2.5 mm. Face moderately wide, silvery white. Front shining blue green. Antennae wholly black, or possibly a little yellowish on lower edge; third joint a little longer than wide, oval, rounded at tip, lateral and inferior orbital cilia vellowish white, about five of the upper cilia on each side black.

Thorax and abdomen dark blue-green, the latter with bronze reflections, and thin white pollen on its sides. Hypopygium black, its lamellae of moderate size, somewhat oval, but narrowing into the stem, about twice as long as wide, whitish with a narrow black border on upper and apical margins, jagged and bristly at lower apical corner, otherwise fringed on apical and upper edges with delicate little brown hairs.

Fore coxae wholly yellow, their anterior surface with minute white hairs. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter nearly bare below, still with a row of very minute yellow hairs on lower inner edge. Hind tibiae scarcely thicker than the others, a very little brownish at tip. Fore and middle tasi about one and one third times as long as their tibiae, the former yellow with the last two joints blackish, first joint as long as the three following joints taken together, third and fifth of about equal length, fourth but little more than half as long as third. Middle tibiae with a pair of rather small bristles below at apical third, their tarsi black from the tip of the first joint, which has a very small bristle above near apical third. Hind tarsi slender, black from the tip of the first joint, which is brownish yellow. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 168) narrow, a little grayish; costa not enlarged at tip of fifth vein; last section of fourth vein a little bent before its middle; third vein bent backward a little at tip; hind margin of wing not indented at tip of fifth vein, evenly rounded; anal angle obsolete, the wing being narrow at root.

Described from 1 male which I took at Kearney, Ontario, July 2, 1909.

Type.—Male, Cat. No. 23048, U.S.N.M.

No. 169. DOLICHOPUS LATRONIS, new species.

Male.—Length 4 mm.; of wing the same. Face wide, narrowed a little below. Front shining green. Antennae black; first joint yellow below for half its width or more; third joint but little longer than wide, somewhat rounded at tip. Lateral and inferior orbital cilia yellowish white, about six of the upper cilia on each side black.

Thorax green; dorsum a little dulled with gray pollen, which is rather thick along the front; pleurae dulled with white pollen. Abdomen green with coppery reflections on the last two segments; the white pollen on its sides abundant. Hypopygium black; its lamellae (fig. 169a) rather large, somewhat subquadrate in outline, whitish with narrow black border on apical margin, which extends a little way on the lower edge and ends abruptly; it also extends narrowly along the upper edge, jagged and bristly at apex, fringed above with delicate but rather long brown hairs.

Fore coxae yellow with a small brown spot on outer side at base, anterior surface with white pollen and a few little black hairs, which are mostly on inner half; middle tarsi black with yellow tips; hind coxae vellow, blackish on most of the outer surface. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter with a row of delicate little yellow hairs on lower inner edge, which are not long enough to call cilia. Middle tibiae with one large bristle below. Posterior tibiae scarcely thickened, very slightly brownish on inner side at tip; they have a glabrous stripe on inner surface just inside of the inner row of large bristles; it is widest near the base and does not reach base or tip. tarsi one and a fourth, middle tarsi one and a third times as long as their tibiae, black from the tip of the first joint; fore tarsi with the first joint longer than the following two taken together, fourth and fifth of equal length; middle basitarsi without a bristle above. Hind tarsi black from the tip of the first joint. Calypters and halteres vellow, the former with black cilia.

Wings (fig. 169) a little grayish; costa a little thickened at tip of first vein, gradually tapering; last section of fourth vein bent beyond basal third; in one specimen the cross vein has a stump vein at its middle; hind margin of wing scarcely indented at tip of fifth vein, rather evenly rounded, the anal angle being rounded but rather prominent.

Described from 2 males taken at Hopedale, Labrador, by Prof. A. S. Packard.

Type.—In the Museum of Comparative Zoology at Cambridge, Massachusetts.

No. 170, DOLICHOPUS HARBECKI, new species.

Male.—Length 4.5-5.5 mm.; of wing the same. Face rather narrow and long, silvery, with a yellowish tinge. Front green with grayish pollen. Antennae (fig. 170b) black; first joint yellow on the lower half; third nearly round in outline, slightly pointed at tip. Lateral and inferior orbital cilia white, about six of the upper cilia on each side black.

Thorax green with slight bronze reflections; dorsum with thick gray pollen along the front, which is usually sharply limited, all the upper portion being covered with almost invisible brown pollen; the large bristles are inserted in minute brown dots; pleurae dulled with grayish pollen. Abdomen green with coppery reflections; the white pollen on its sides abundant. Hypopygium black; its lamellae of moderate size, somewhat triangular, yellowish white with a black border on the apical margin, jagged and bristly on lower half of the apical edge, the upper half being fringed with slender brown hairs, the upper and lower edges with minute pale hairs; there is a pair of

inner appendages which are more conspicuous than usual; they have a rather large, triangular, brown tip.

Fore coxae yellow, with the extreme base on outer side brown; their anterior surface with silvery pollen and minute yellow hairs. Middle and hind coxae black with yellow tips. Femora and tibiae yellow, each with one preapical bristle, the latter without cilia below, still with a row of delicate little yellow hairs on lower inner edge. Posterior tibiae not thickened, the usual glabrous stripe on upper surface broken up by little hairs, but inside of the inner row of large bristles is a glabrous stripe, widest near the base and reaching nearly to the tip. Middle tibiae with one bristle below, their basitarsi without a bristle above. Fore tarsi scarcely one and a fourth times as long as their tibiae, first joint a little longer than the three following joints taken together, fourth and fifth of nearly equal length. Middle and hind tarsi about one and one-third times as long as their tibiae; all tarsi black from the tip of the first joint. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 170) grayish, with a conspicuous brown spot near the tip, extending from the costa back of the fourth vein and from the bend in the fourth vein to the apex of the wing; costa with a small knotlike enlargement at tip of first vein; last section of fourth vein a little bent beyond its basal third; wings long and narrow, of somewhat equal width, narrowest at tip of fifth vein, where there is a small sinus; between the fifth and sixth veins the hind margin has an outward swell; anal angle prominent, with a lobe extending toward the root of the wing; hind margin fringed with conspicuous but very delicate hairs.

Female.—Face wide, silvery white; legs and tarsi as in the male, except that the glabrous stripe on upper surface is more distinct, but the one on inner surface is wanting; wings (fig. 170a) without a brown spot, of normal form, rather evenly rounded behind, scarcely indented at tip of fifth vein; costa without an enlargement; anal angle rounded, rather prominent.

Described from 8 males and 2 females. J. M. Aldrich has 1 pair taken at Franconia, New Hampshire, and 1 male from Roxborough, Pennsylvania (Harbeck), June 7. The United States National Museum has 1 male from the White Mountains, New Hampshire. Mr. N. Banks took 1 at North Fork, Swannanoa, Black Mountains, North Carolina, May. C. W. Johnson took it at Mount Washington, New Hampshire, July 21; Glen House, New Hampshire, July 23; Mount Greylock, Massachusetts, July 25; and 1 female at Capens, Maine, July 16.

Type.—Male, Cat. No. 23049, U.S.N.M., from Roxborough, Pennsylvania.

No. 171. DOLICHOPUS SLOSSONAE, new species.

Male.—Length 4.5-5.5 mm.; of wing the same. Face rather wide, a little narrowed below, ocher yellow, more white below in some specimens. Front green. Antennae black; first joint yellow below; third joint somewhat orbicular, but slightly pointed at tip. Lateral and inferior orbital cilia whitish, from 8 to 12 of the upper cilia on each side black.

Thorax green with slight bronze reflections; dorsum with rather abundant gray pollen along the front, which is quite sharply marked posteriorly, the disk being covered with an almost invisible brown pollen; the large bristles are inserted in little black dots; pleurae dulled with a little gray pollen. Abdomen green, sometimes with coppery reflections; the white pollen on its sides not very abundant. Hypopygium black; its lamellae (fig. 171a) rather large, somewhat triangular, white with a narrow apical black border, jagged and bristly on apical margin, fringed with brown hairs on the rounded upper apical corner.

Fore coxae yellow, their anterior surface covered with minute black hairs, which are mixed with some yellow ones. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter without cilia below, but with a row of rather conspicuous, very delicate, little yellow hairs on lower inner edge. Posterior tibiae scarcely thickened; the usual glabrous stripe on upper side narrow and broken, but there is another one on inner surface just inside of the inner row of large bristles; it is wide at base and extends nearly to the tip. Fore and middle tarsi about one and a third, hind tarsi one and a half times as long as their tibiae, black from the tip of the first joint; first joint of fore tarsi a little longer than the three following joints taken together, fifth shorter than fourth; middle basitarsi without a bristle above, their tibiae with one large bristle below. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 171) grayish, tinged with brown along the front, usually only slightly so; costa with a small knotlike enlargement at tip of first vein; last section of fourth vein bent beyond its basal third; wings rather narrow and of nearly parallel width; hind margin of wing not indented at tip of fifth vein; anal angle prominent.

Female.—Face wide, silvery white; wings more evenly rounded on the hind margin, still not very wide; anal angle prominent.

Described from 7 males and 1 female. J. M. Aldrich has 4 males and 1 female, taken at Franconia, New Hampshire, by Mrs. Annie Trumbull Slosson. I took 1 male at Colden, Erie County, New York, July 12. C. W. Johnson took 2 males, 1 at Mount Ascutney, Vermont, July 11, and 1 at Eastport, Maine, July 15.

Type.—Male, Cat. No. 23050, U.S.N.M., from Franconia, New Hampshire.

The form of the wing in this species is very much like that of harbecki but the anal angle has not the lobe extending toward the root of the wing as in that species, nor does it have the sinus at tip of fifth vein; it also lacks the black spot at tip of wing. The pollen on the dorsum of the thorax is about the same in both species, the feet differ a little.

No. 172. DOLICHOPUS VIRGINIENSIS, new species.

Male.—Length 4.7 mm.; of wing 4.5 mm. Face moderately wide, golden yellow, paler below. Front green, dulled with gray pollen. Antennae black; first joint yellow below; third joint about as long as wide, somewhat conical in outline, obtusely pointed at tip. Lateral and inferior orbital cilia whitish, about five of the upper cilia black.

Thorax green with bronze reflections, which sometimes form a median vitta on the dorsum, which has gray pollen that is most conspicuous in front; pleurae dulled with whitish pollen. Abdomen green with reddish coppery reflections; the white pollen on its sides abundant. Hypopygium black; its lamellae of moderate size, somewhat triangular, a little rounded at apex, whitish with rather narrow black apical border, jagged and bristly at lower corner, otherwise the apical margin is fringed with black hairs.

Fore coxae yellow, with minute yellow hairs on the anterior surface. Middle and hind coxae black with yellow tips. Femora and tibiae yellow, middle and hind femora each with one preapical bristle, the latter without cilia below, nearly bare on lower half, where there are only some very delicate yellow hairs. Posterior tibiae a very little thickened, especially near the base, where there is a little hollow on inner surface, which is glabrous for the entire width at this point, the glabrous part tapering toward the tip of the tibiae and ending a little beyond its middle. Fore and middle tarsi one and one-fourth times as long as their tibiae; fore tarsi wholly yellow, the fifth joint being the palest and about as long as the fourth, first joint as long as the three following taken together, middle tarsi yellow, a very little darker from the tip of the first joint. Hind tarsi black from the tip of the first joint. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 172) rather evenly tinged with brown, but not dark; costa scarcely enlarged at tip of first vein; last section of fourth vein a little bent beyond its basal third; rather widely separated from and nearly parallel with third vein; hind margin of wing not indented at tip of fifth vein; between the tips of fifth and sixth veins there is a shallow sinus and another between tip of sixth vein

and the anal angle, forming two small lobes, one at tip of sixth vein and one at the anal angle, which is produced toward the root of the

Described from 2 males taken by C. T. Greene at Great Falls, Virginia, June 27, 1915.

Type.—Male, Cat. No. 23051, U.S.N.M.

This species is very much like both slossonae and harbecki in the form of the wing.

No. 173. DOLICHOPUS BAKERI Cole.

Dolichopus bakeri Cole, Pomona College Journal of Entomology and Zoology, vol. 4, 1912, p. 839.

Male.—Length 3.75-4.75 mm.; of wing 3.75-4.5 mm. Face wide and short, white, tinged with yellow just below the antennae. Front purple, narrowly green above the antennae and along the orbits, sometimes mostly green. Antennae wholly black; third joint somewhat oval, a little longer than wide, pointed at tip. Lateral and inferior orbital cilia pale vellow, about seven of the upper cilia on each side black.

Thorax green with coppery reflections, sometimes more bronze brown; pleurae dulled with white pollen. Abdomen green with copperv reflections, the apical segments mostly copperv. Hypopygium black with coppery reflections: its lameliae (fig. 173a) rather large, somewhat triangular, but a tittle rounded at apical edge, whitish with a black border on apical margin, jagged and bristly at apex.

Fore coxae yellow, a little blackened at base on outer side, anterior surface with conspicuous little black hairs. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with two preapical bristles, the latter ciliated on lower inner edge with long, delicate, yellow hairs, the longest of which are a little longer than the width of the femora. Posterior tibiae thickened and a little compressed, the usual glabrous stripe on upper edge distinct, inner surface also with a glabrous stripe for about one-third their length. Fore and middle tarsi a little longer than their tibiae, hind tarsi one and a third times as long as their tibiae; all tarsi black from the tip of the first joint; first joint of fore tarsi scarcely as long as the remaining four joints taken together; middle basitarsi about as long as the two following joints together, without a bristle above, their tibiae with one long bristle below. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 173) grayish; costa with a small enlargement at tip of first vein, gradually tapering; last section of fourth vein a little bent just before its middle; third vein nearly straight; hind margin of wing a little indented at tip of fifth vein; anal angle prominent.

Female.—Very much like the male in color, form of antennae, preapical bristles, and form of wings and tarsi; the face is wide, hind

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femora without cilia, but with a row of rather short, delicate, yellow, closely placed hairs on lower inner edge; the costa is not enlarged at tip of fifth vein; the anal angle is not quite so prominent as in the male.

Redescribed from 4 males and 5 females taken at Socorro, New Mexico, by S. W. Williston, all in the collection of J. M. Aldrich; 1 male taken by E. P. Van Duzee at Santa Cruz, Island, California; 1 male taken at Salt Lake, Utah, June 26, by H. S. Barber and in the United States National Museum; and 1 I took at Fresno, California, May 6, 1915. T. N. Willing took a female at Point Albert, Regina, June 19, 1905.

[The type, a female from Laguna, California, in the collection of the Department of Zoology, Pomona College, was sent me for examination, and from characters then noted I identified the Socorro material.—J. M. A.]

No. 174. DOLICHOPUS AURIFACIES Aldrich.

Dolichopus aurifacies Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 20.

Male.—Length 4.8 mm.; of wing 4 mm. Face moderately wide, narrowed below, golden yellow. Front shining green or blue-green. Antennae (fig. 174a) yellow; first joint rather slender; third a little longer than wide, conical in outline, pointed at tip, which is more or less infuscated; arista longer than the antennae, black, its first joint unusually long, about one-fourth of its entire length. Lateral and inferior orbital cilia yellowish, only two or three of the upper cilia on each side black.

Thorax green; dorsum dulled a little with coarse brown pollen, with a small coppery spot on each side at the suture; pleurae dulled with a little yellowish gray pollen. Abdomen green with bronze reflections; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black; with green reflections on basal portion; its lamellae (fig. 174b) large and inserted near apical third, somewhat elliptical in outline, but narrowed into the stem, whitish with a narrow black border on upper and apical margins, and with numerous brown dots on the disk, jagged and bristly at apex, fringed above with delicate short brown hairs, below with a few pale hairs.

Coxae yellow, middle pair with two blackish spots on outer surface; fore coxae with minute yellowish hairs on the anterior surface. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter without cilia below. Posterior tibiae thickened; the usual glabrous stripe on upper surface distinct but does not reach the tip, being terminated by the uniting of the two rows of large bristles, inner surface with another glabrous stripe, which is wide at base, narrow at tip, reaching the entire length of the tibia. Middle tibiae with one large bristle below, their basitarsi without a bristle above. Fore tarsi one and a half times as long as

their tibiae, yellow, darkened toward their tips, last two joints, black; first joint about as long as second and third taken together, fourth and fifth of about equal length. Middle tarsi one and a fourth times as long as their tibiae, black from the tip of the first joint, still the second paler at base. Hind tarsi one and a third times as long as their tibiae, blackened from the middle of the first joint, which has three large bristles on upper surface.

Wings (fig. 179) short, grayish; costa with a very small knot-like enlargement at tip of first vein; last section of fourth vein bent at its basal third; hind margin of wing scarcely indented at tip of fifth vein, rather evenly rounded; anal angle rounded but rather prominent.

Female.—The type female has the face wide, almost silvery white, a little tinged with yellow on upper portion; third antennal joint a little longer and more pointed than in the male; wings a littler wider, bend of fourth vein a little farther from the cross-vein, anal angle a little more prominent, and third vein almost straight, in the male the third vein is bent backward at tip a little; costa without an enlargement.

Redescribed from the type material in the collection of J. M. Aldrich, 3 males and 1 female, 2 males and the female were taken at Knoxville, Tennessee, May 17, 1891 (H. E. Summers), the other male was taken at Lawrence, Kansas, by J. M. Aldrich; and 1 male from the collection of J. S. Hine taken by Bridwell, at Baldwin, Kansas, June.

The point of insertion of the hypopygial lamellae is rather unusual, as is also the long first joint of the arista.

No. 175. DOLICHOPUS CAROLINENSIS, new speies.

Male.—Length 5.5 mm. Face wide, narrowed below, almost ocher vellow. Front dark shining green. First two antennal joints yellow, second small; third joint black, broad, somewhat orbicular, still pointed at tip. Lower orbital cilia yellow, those of upper half black.

Thorax green; dorsum with the sides and a median line bronzebrown, a little dulled with gray pollen; pleurae more blackish with gray pollen. Abdomen green with wide black incisures; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black; its lamellae (fig. 175a) of moderate size, somewhat oval, about one and a half times as long as wide, whitish with narrow black border on upper and apical margins, jagged and bristly at apex, fringed above with rather long black hairs.

Fore coxae yellow, with a small black spot at base on outer side, anterior surface with silvery pollen and little black hairs. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter without cilia below. Posterior tibiae but little thickened, more so at tip and on inner side just before the middle; blackish at tip on inner side, also with a slight brownish shade at base on upper side and on inner side where the swelling is near the middle; the usual glabrous stripe on upper surface distinct, but broken by little hairs. All tarsi black from the tip of the first joint; fore and middle ones a little longer than their tibiae, the former with the first joint about as long as the remaining four taken together. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 175) grayish, with a slight brown tinge in front of third vein, costa scarcely enlarged at tip of first vein; last section of fourth vein bent before its middle; hind margin of wing quite deeply notched at tip of fifth vein, and with a conspicuous sinus between the tip of fifth and sixth veins, leaving a small lobe back of fifth vein; although the anal angle is prominent there is scarcely what could be called a lobe at tip of sixth vein.

Female.—Face wide, grayish white; the body color is more bronze-brown than green; wings (fig. 175b) without the slightest enlargement of the costa at the tip of the first vein; their hind margin not quite so deeply notched at tip of fifth vein, although considerably so, and without sinus; the anal angle is rounded off, not at all prominent, the hind margin being evenly rounded. Middle tibiae with a row of four large bristles below, one of which is a little to one side of the line of the others, their basitarsi without a bristle above.

Described from 1 pair taken at Southern Pines, North Carolina, May 1, 1912, by A. H. Manee.

Type and allotype.—In the collection of Mr. Nathan Banks, Cambridge, Massachusetts.

This is much like fulvipes Loew, but the wing has a deep notch at tip of fifth vein, in fulvipes there is only a small notch, and the sinus is much deeper between the tips of fifth and sixth veins, leaving a distinct lobe at tip of sixth vein, while in carolinensis there is no lobe at that point but a small one just back of fifth vein caused by the deep notch at fifth vein.

No. 176. DOLICHOPUS IMPERFECTUS, new species.

Male.—Length 4.7 mm.; of wing 5 mm. Face rather narrow with parallel sides, reaching nearly to the lower corner of the eye, rounded on lower edge, silvery white, only a little yellowish just below the antennae. Front dark shining green. First two antennal joints yellow, first joint rather long with conspicuous black hairs (third joint missing). Lateral and inferior orbital cilia whitish, about six of the upper cilia on each side black.

Thorax dark shining green with bronze and blue reflections and with a coppery spot on each side at the suture; pleurae dulled with

gray pollen. Abdomen green with bronze reflections; the white pollen on its sides rather thin. Hypopygium (fig. 176) black, very small, tipped with what appears to be the rudiments of lamellae, which are whitish in color.

Coxae vellow, outer surface of middle and hind ones blackened; fore coxae covered on their anterior surface with silvery pollen, with a few black hairs along the inner edge and a few longer ones at base, the usual bristles at tip. Femora and tibiae vellow. Middle and hind femora each with one preapical bristle, the latter nearly bare below. Posterior tibiae a little thickened; the usual glabrous stripe on upper surface distinct, but conspicuous only for half the length of the tibiae, their tips slightly brownish. Fore tarsi rather stout, about as long as their tibiae, black from the tip of the first joint, still the second joint yellowish; first joint as long as the three following taken together. Middle tipiae with two bristles below, their basitarsi narrowly black at tip, without a bristle above. Hind tarsi black with the first joint yellowish on basal two-thirds and with two large bristles above. Calypteres and halteres vellow, the former with black cilia.

Wings (fig. 176a) grayish; costa with an elongated enlargement at tip of first vein; last section of fourth vein a little bent just before its middle; hind margin of wing a little indented at tip of fifth vein; anal angle rounded, not prominent.

Described from 1 male taken at Calumet, Illinois, in July, by E. P. Van Duzee.

Type.—Male, Cat. No. 23052, U.S.N.M.

No. 177. DOLICHOPUS VITTATUS Loew.

Dolichopus vittatus Loew, Neue Beitr., vol. 8, 1861, p. 20; Mon. N. Amer. Dipt., pt. 2, 1864, p. 55.—Melander and Brues, Biol. Bull., vol. 1, 1900, p. 148.

Male.—Length 5-6 mm.; of wing 5-5.5 mm. Face rather wide, silvery white, more or less tinged with yellow on upper portion. Front shining green, often largely blue or violet. Antennae yellow; third joint more or less brown at tip, a little longer than wide, rather pointed at tip. Lateral and inferior orbital cilia yellowish white, about five of the upper cilia on each side black.

Thorax green with sharply defined median, and wider, less distinct lateral vittae on the dorsum; often with blue or violet reflections, sometimes almost wholly violet on the dorsum; the vittae are usually coppery in color but sometimes they are more bronze or golden, in specimens with the dorsum violet they may be shining green with scarcely a trace of bronze; anterior portion of the dorsum a little dulled with gray pollen; pleurae dulled with whitish pollen. Abdomen green with coppery reflections; the white pollen on its sides

abundant and extending upon the dorsum. Hypopygium black with metallic reflections; its lamellae (fig. 177a) rather small, somewhat elliptical, one and a half times as long as wide, white with a black border on apical and upper margins, that above very narrow, jagged and bristly at apex, fringed above with a few rather stiff short black hairs.

Coxae yellow, middle ones blackened on outer surface; fore coxae with minute black hairs along inner edge, anterior surface with silvery pollen and little white hairs, sometimes there are a few black ones intermixed. Femora and tibiae vellow. Middle and hind femora each with one preapical bristle, the latter without cilia below but with a row of very delicate little vellow hairs on lower inner edge. Posterior tibiae a little thickened, their inner surface glabrous from near the base nearly to apical fourth. Fore and middle tarsi about one and a fourth times as long as their tibiae, middle ones black from the tip of the first joint, anterior ones from the middle of third ioint; first joint of fore tarsi about as long as the following three taken together, fourth and fifth of nearly equal length. Middle tibiae with three bristles below, one pair at apical third and one bristle at basal third, their basitarsi with one large bristle near apical third of upper side. Hind tarsi black from the tip of the first joint. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 177) grayish, usually tinged with brownish in front of third vein; costa with a conspicuous elongated enlargement at tip of first vein; tip of third vein bent backward a little; last section of fourth vein bent at right angles near its middle, the bend having a stump of a vein at its first angle and sometimes also one at its upper angle, the vein running nearly straight from upper angle to its tip; hind margin of wing only a little indented at tip of fifth vein; anal angle prominent.

Female.—Face wider than in the male; fore tarsi but little longer than their tibiae, usually black from the middle of the third joint, sometimes infuscated a little from the tip of the first joint; wing as in the male except that the costa is not enlarged at tip of fifth vein; bristles of middle tibiae and tarsi as in the male.

Redescribed from many specimens from the following localities: Brookings, South Dakota (Aldrich); Lafayette, Indiana, June 8–11; Princeton, New Jersey, July 21; Cuyahoga Falls, Ohio, August 14; Western New York, June 10–October 19; Toronto, Ontario, July 4; Port Credit, Ontario, July 15.

Type localities.—Chicago, Illinois, and Genesee, New York. Melander and Brues report it from Wisconsin; Chagnon from Montreal, Canada.

Type.—In Museum of Comparative Zoology, Cambridge, Massachusetts.

No. 178, DOLICHOPUS CELERIPES, new species.

Male.—Length 4 mm.; of wing 3.75 mm. Face rather wide, silvery white. Front green with brownish pollen which is almost invisible but dulls the front. First and second antennal joints yellow; third joint black, a little yellow at base, about as long as wide, pointed at tip. Lateral and inferior orbital cilia vellow, about five of the upper cilia on each side black.

Thorax green with slight bronze reflections, dulled with brownish pollen on the dorsum, this pollen more gray along the front; pleurae dulled with white pollen. Abdomen green, dulled with white pollen, which is more abundant on its sides. Hypopygium black; its lamellae of moderate size, somewhat round, but a little longer than wide, white with a rather narrow black border; jagged and bristly at apex. fringed above with dark hairs which appear more or less vellowish.

Coxae yellow, middle pair a little grayish on outer side; anterior surface with silvery pollen and very minute white hairs, still they appear almost bare; the black bristles at tip rather weak. Femora and tibiae yellow. The hairs on all femora unusually small. only a few longer ones on upper edge of hind pair. Middle and hind femora each with one preapical bristle, the latter without cilia below. Fore tibiae besides the usual bristles with a long slender one at tip on the posterior side which sometimes appears reddish and is fully twothirds as long as their basitarsi. Middle tibiae with one bristle below, their basitarsi without a bristle above. Hind tibiae slightly thicker than the others, the usual glabrous stripe on upper surface poorly defined; lower edge with a row of bristle-like hairs below. Fore and middle tarsi about one and a fourth times as long as their tibiae, with the tips of the joints brown or blackish, darker at tip; second joint about half as long as first, third a little shorter than second, fourth and fifth of nearly equal length, fourth slightly shorter than third. Hind tarsi blackish from the tip of first joint. Calypters, their cilia and the halteres vellow.

Wings (fig. 178) grayish; costa with a conspicuous enlargment at tip of first vein, which tapers into the costa; last section of fourth vein a little bent near basal third; hind margin of wing scarcely indented at tip of fifth vein, rather evenly rounded, the anal angle being nearly obsolete.

Female.—Face wide, silvery gray; third antennal joint a little smaller than in the male; coxae, legs, tarsi and wings about as in the male, except that there is no enlargment of the costa at tip of first vein and no pale bristle at tip of fore tibiae like the one in the male. The thorax is more metallic brown or blackish, but it seems to be discolored in the only female we have.

Described from 1 male from Colorado, taken by C. F. Baker; and 1 pair taken by Childs at Hood River, Oregon, August 2, 1914.

Type.—Male, Cat. No. 23053, U.S.N.M., from Oregon.

No. 179. DOLICHOPUS SCAPULARIS Loew.

Dolichopus scapularis Loew, Neue Beitr., vol. 8, 1861, p. 22; Mon. N. Amer-Dipt., pt. 2, 1864, p. 64.—Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 20.—Melander and Brues, Biol. Bull., vol. 1, 1900, p. 148.—Johnson, Insects of New Jersey, 1909, p. 756.

Male.—Length 3-5.7 mm.; of wing 4-5.7 mm. Face rather wide, only a little narrowed below, silvery white, sometimes a very little tinged with yellow just below the antennae. Front green, usually with blue, rarely with violet reflections, with grayish pollen along the orbits. Proboscis and palpi dark yellow. Antennae wholly yellow, or nearly so; third joint from one and a fourth to twice as long as wide, obtusely pointed at tip. Lateral and inferior orbital cilia yellowish white, about seven of the upper cilia on each side black.

Thorax green; dorsum often with bronze reflections, sometimes it is mostly blue or violet in color; humeral callosity yellow, sometimes only yellow on its lower edge; usually the lateral edges of the dorsum from near the root of the wing to the scutellum and lateral corners of scutellum are yellow, sometimes the scutellum is yellow with a metallic spot in the center at base, but sometimes the only vellow to be found on the thorax is a line on lower edge of the humeral callosity; the dorsum is dulled with rather conspicuous grayish or vellowish pollen; pleurae dulled with white pollen. Abdomen green with bronze reflections; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black, usually with more or less yellow especially at tip; its lamellae of moderate size, somewhat triangular, with the upper angle broadly rounded, white with rather narrow black border on apical and upper margins, jagged and bristly on lower half of apical margin, above that fringed with black hairs.

Coxae yellow, middle ones with a blackish spot on outer surface; fore coxae with minute yellow hairs on the anterior surface and usually with a few little black ones along their inner edge. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter ciliated for about half their length on lower inner edge with yellow hairs, the longest of which is scarcely as long as the width of the femora; they begin before the middle of the femora and do not reach its tip, but are continued to tip and base by little yellow hairs. Posterior tibiae only a little thickened, the usual glabrous stripe on upper surface although not conspicuous is distinct and reaches from near the base to beyond the middle of the tibiae; the inner surface is glabrous from near the base nearly to the middle

and is continued to the tip by a very narrow line just inside of the inner row of large bristles. Fore tarsi more than one and a half times as long as their tibiae, the first two joints being nearly as long as the tibia, first three joints yellow, still sometimes a very little infuscated from the tip of first joint, fourth and base of fifth black or blackish, fifth decidedly yellowish on apical half, shorter than fourth. Middle tarsi about one and a fourth times as long as their tibiae, infuscated from the tip of the first joint, still often quite yellow to the tip of the third joint; first joint with a bristle beyond the middle of its upper side, their tibiae with three bristles below, one pair at apical third and one bristle at basal third. Hind tarsi nearly one and one-third times as long as their tibiae, colored like the middle Calvoters and halteres yellow, the former with black cilia.

Wings (fig. 179) grayish, sometimes slightly tinged with yellowish brown in front; costa yellowish on inner edge, with a slight enlargement at tip of first vein, which is yellowish and usually has a brown spot on its surface; last section of fourth vein a little bent near its basal third, sometimes this bend is very small, leaving this section of fourth vein nearly straight and almost parallel with third vein; usually the bend is more conspicuous. Hind margin of wing only slightly indented at tip of fifth vein, rather evenly rounded, the anal angle being broadly rounded, not prominent.

Female.—Face a little wider than in the male; fore coxae usually with more black hairs on inner edge; fore tarsi about one and a fourth times as long as their tibiae, colored as in the male, except that the fifth joint does not seem to be any paler toward its tip, but it is shorter than the fourth; second joint about two-thirds as long as the first, being shorter in proportion than in the male; posterior tibiae without a glabrous stripe on inner side; hind femora without cilia, but have a row of small delicate yellow hairs on their lower inner edge, which are quite easily seen; wings without the enlargement at tip of first vein, otherwise they are about as in the male.

Redescribed from many specimens from the following locations: Pittsburgh, Pennsylvania, June 3; Lafayette, Indiana (Aldrich), July 6; Knoxville, Tennessee, May 19 (Summers); Lawrence, Kansas (Aldrich); Washington, District of Columbia, June; Dallas, Texas, May 31; Western New York, June 22-September 2; Fort Erie, Ontario, July 2.

Type localities .- Washington, District of Columbia: Illinois, and Middle States. Aldrich reports it from Kansas, Pennsylvania, and Ohio; Melander and Brues from Wisconsin; Johnson, Insects of New Jersey, from Iona, New Jersey, September 12.

Type.—In Museum of Comparative Zoology, Cambridge, Massachusetts.

No. 180. DOLICHOPUS DOMESTICUS, new species.

Male.—Length 4.75-5.2 mm.; of wing 5 mm. Face rather narrow, yellowish, more silvery below. Front shining green, in one specimen violet. Antennae yellow; third joint infuscated on apical half, longer than wide, pointed at tip. Lateral and inferior orbital cilia whitish; about five of the upper cilia on each side black.

Thorax shining green; dorsum with violet reflections, and with thin gray pollen along the front. Abdomen green with coppery reflections and black incisures; the white pollen on its sides abundant. Hypopygium black with green reflections; its lamellae (fig. 180a) of moderate size, somewhat subquadrate, but narrowing into the stem; this narrowing is about equal on each side and they are cut off nearly straight at apex; white with a narrow black edge at apical corners, jagged and bristly at apex.

Coxae, femora, and tibiae yellow. Middle coxae, and sometimes the hind pair, a little blackened on outer surface; anterior surface of fore coxae with silvery pollen and very minute pale hairs. Middle and hind femora each with one preapical bristle, the latter ciliated on lower inner edge with long slender yellow hairs, the longest of which are near the middle and a little longer than the width of the femora, from the middle of the femora to the base the cilia are continued by little yellow hairs. Posterior tibiae only a little thickened, their inner surface with a glabrous space near the base, which is about one-third as long as the tibia. All tarsi black from the tip of the first joint; middle tarsi one and a fourth, fore and hind tarsi one and a third times as long as their tibiae; fore tarsi with the joints of decreasing length; middle basitarsi with one large bristle above. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 180) grayish; costa very slightly enlarged at tip of first vein; last section of fourth vein a little bent just beyond its basal third; hind margin of wing slightly indented at tip of fifth vein; anal angle rather prominent.

Female.—Face wider, but narrow for a female; third antennal joint smaller and less infuscated; tarsi about as in the male, except that they are a little shorter; hind femora with a row of very small yellow hairs on lower inner edge; hind tibiae more slender and without the glabrous stripe on inner side; wing about as in the male.

Described from 3 males and 2 females; 1 male and the 2 females were taken at Westville, New Jersey (Johnson), July 21; 1 male at East Aurora, New York, August 7; and 1 male in the Loew collection taken at New York.

Type.—Male, Cat. No. 23054, U.S.N.M. from East Aurora, New York.

This species comes close to scapularis Loew, but the humeri are not at all yellow nor is there any yellow on the thorax. It differs

also in having the cilia on the hind femora longer and more delicate. The Loew specimen differs from the others in having the front violet and the face white; the bend in the fourth vein is greater, almost broken. I do not think there is any doubt of its being the same species.

No. 181, DOLICHOPUS LATIPES Loew.

Hygroceleuthus latipes Loew, Neue Beitr., vol. 8, 1861, p. 5; Mon. N. Amer. Dipt., pt. 2, 1864, p. 17.—Aldrich, Kansas Univ. Quart., vol. 2, 1893, pp. 24 and 155, pl. 1, fig. 26.—WHEELER, Proc. Calif. Acad. Sci., vol. 2, 1897, p. 2.—Melander and Brues, Biol. Bull., vol. 1, 1900, p. 128, fig.

Male.—Length 5.5-6 mm.; of wing 5 mm. Face moderately narrow, long, reaching the lower corner of the eye, of nearly equal width, silvery white, slightly tinged with yellow just below the antennae. Front dark shining green. Antennae yellow; first joint long; third with the apical half blackened, oval, scarcely pointed at tip, about one and a half times as long as wide. Lateral and inferior orbital cilia yellowish white, four or five of the upper cilia on each side black.

Thorax dark shining green with a little gray pollen on the anterior part of the dorsum; pleurae dulled with white pollen. Abdomen dark shining green, sometimes with bronze reflections; the white pollen on its sides moderately abundant. Hypopygium black with green reflections; its lamellae rather small, somewhat quadrilateral but with the apical margin broadly rounded, whitish with a black border on the apical margin, which is jagged and bristly.

Fore coxae yellow with a few minute yellow hairs on their anterior surface and usually with a few black ones on inner edge near the base; middle and hind coxae black with yellow tips, sometimes the latter mostly yellow, blackened only on the basal half of outer side; femora and tibiae yellow; middle and hind femora each with one preapical bristle, the latter without cilia below, but they have three bristlelike hairs on upper outer edge; these are scarcely in a row with the preapical bristle, and increase in length apically; middle tibiae with a bristle on upper side near the middle which is nearly twice as long as the other bristles on these tibiae, and with two large bristles below, one near basal and one near apical third. Posterior tibiae but little thickened, their bristles longer than usual; on their inner surface there is a glabrous stripe just inside of the inner row of large bristles, which is often of a darker color. Fore tarsi a little longer than their tibiae, black from the tip of the first joint, which is nearly as long as the remaining four taken together; fifth joint a little longer than the fourth; middle tarsi (fig. 181a) scarcely longer than their tibiae; first joint normal, about as long as the three following joints taken together, without a bristle above, yellow or whitish with extreme tip black; last four joints compressed; second joint widening apically, yellowish, but black on upper edge and at apex; last three joints black, third and fourth of nearly equal width, fifth about half as long and wide as fourth, somewhat round in outline; second, third, and fourth joints fringed above with black hairs. Hind tarsi black from the tip of the first joint. Calypters and halteres yellow, the former with black cilia, which often appear reddish in certain lights.

Wings (fig. 181) tinged with brown on anterior half, more grayish on posterior half; costa with an elongated enlargement at tip of first vein, which is as long as the cross-vein; last section of fourth vein bent near its middle; hind margin of wing a little indented at tip of fifth vein; anal angle rounded.

Female.—Face wide, of the usual length, silvery white; femora with the same three bristle-like hairs before the preapical bristle as in the male; middle tibiae with a bristle a little longer than the others near its middle; their tarsi plain, slightly shorter than their tibiae, black from the tip of first joint; still the second sometimes a little yellowish; three middle joints slightly compressed; costa without an enlargement at tip of first vein.

Redescribed from specimens from Brookings, South Dakota; August 12; Wisconsin, August; Moscow, Idaho (Aldrich), July 22; Franconia, New Hampshire; Pullman, Washington (Melander), June 30; Lewiston, New York, August 11; Ithaca, New York, July 22; Grange Island, New York, August 8; Yellowstone Lake, Montana (Melander), August 9; Three Forks, Montana, August 1; Quebec, Canada, August 10; Clayton, British Columbia, August 9; Ottawa, Canada, September 8; Ridgeway, Ontario, August 8, September 6.

Type locality.—Red River of the North. Aldrich reports it from South Dakota, Wyoming, Connecticut, and Wisconsin; Wheeler from Wisconsin and Illinois; Melander and Brues from Massachusetts and Pullman, Illinois.

No. 182. DOLICHOPUS ALDRICHII Wheeler.

Hygroceleuthus aldrichii Wheeler, Proc. Calif. Acad. Sci., vol. 2, 1897, p. 3, pl. 1, fig. 1-3.—Melander and Brues, Biol. Bull., vol. 1, 1900, p. 129, figs.

Male.—Length 3.5-5 mm.; of wing 4-4.5 mm. Face rather narrow and long, not reaching the lower corner of the eye, yellowish white, sometimes nearly pure white. Front shining green. Antennae black with the first two joints yellow on the lower inner side; first joint long and with long black hair; third joint oval, short, a little pointed at tip, not much longer than wide; arista rather thick. Lateral and inferior orbital cilia yellowish, about ten of the upper cilia on each side black.

Thorax green with bronze reflections and rather abundant gray pollen on the dorsum. Abdomen green with coppery reflections on

the hind margins of the segments; the white pollen on its sides conspicuous. Hypopygium black; its lamellae rather small, somewhat triangular, yellowish with a brown border, which is more conspicuous when viewed from below, scarcely at all jagged, fringed with little vellowish hairs.

Fore coxae yellow with a green stripe on outer posterior edge; anterior surface with silvery pollen and minute delicate white hairs. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter without cilia below. Posterior tibiae a little thickened, blackish at tip, but the black not well defined, with a row of five large bristles on the lower outer edge, their inner surface with a glabrous stripe, which is widest at their base. Fore tarsi plain, not as long as their tibiae, stout, black from the tip of the first joint. Middle tarsi (fig. 182a) about as long as their tibiae, black from the tip of the first joint, which is mostly whitish, without a bristle above; second, third, and fourth joints a little compressed, but rather thick, fringed on both edges with black hairs. Hind tarsi black with the base of the first joint a little vellowish; calypters and halteres yellow, the former with long black cilia.

Wings (fig. 182) grayish, darker in front of third vein; costa a little thickened at tip of first vein, but this thickening is cylindrical and more readily seen from the front of the wing; last section of fourth vein considerably bent near its middle; third vein bent backward at tip; hind margin of wing a little indented at tip of fifth, bilobed at the anal angle, which is cut off very straight at the base of the wing, not rounded as usual.

Female.—Face wide but rather long, yellowish white; antennae and fore and hind tarsi about as in the male; fore coxae covered with black hairs on the anterior surface; middle tarsi slightly compressed, colored about as in the male; wings with the hind margin evenly rounded; costa without an enlargment.

Redescribed from 8 males and 4 females from Colorado and Moscow, Idaho (Aldrich); one of the latter was taken Aug. 23; 1 male from Pullman, Washington, July 12; and 1 female taken at Uinta National Forest, Utah, Aug. 29, on Currant Creek, at 8,000 feet elevation.

Type localities.--Moscow, Idaho, Wyoming; Melander and Brues report it from Idaho, Wyoming, and Colorado.

Type.—In American Museum of Natural History, New York City.

No. 183. DOLICHOPUS BOLSTERI, new species.

Fig. 1, page 3.

Male.—Length, 5 mm.; of wings, 5.5 mm. Face wide, scarcely narrowed below, silvery gray. Front shining green. Antennae wholly black; third joint about as long as wide, somewhat triangular, pointed at the tip. 'Lateral and inferior orbital cilia yellowish white, about seven of the upper cilia on each side black.

Thorax green, dorsum a little dulled with pollen, which is gray along the front, becoming more brownish on the disk; and with a median coppery vitta, which is divided by a fine green line; pleurae dulled with gray pollen. Abdomen green with narrow black incisures, in front of which there are coppery reflections; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black, rather short; its lamellae (fig. 183a) small, triangular, but rounded at apex, yellowish with a broad black apical border, a little jagged and bristly at lower corner, otherwise fringed with little black hairs on apical and upper margins, and hairy on the disk.

Fore coxae wholly vellow, their anterior surface covered with minute black hairs; there are only a few pale hairs at upper outer corner. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter nearly bare below, but with a row of minute yellow hairs on lower inner edge. Posterior tibiae scarcely thickened. Middle tibiae with a pair of bristles at basal third below and one large and two small bristles before them on the lower edge; their basitarsi with one large bristle near apical third of upper edge. Fore and middle tarsi about one and one third times as long as their tibiae. black from the tip of the first joint; fore tarsi with the fifth joint as long as third and a little longer than fourth, a very little compressed, first joint as long as the three following joints taken together, second a little longer than third. Hind tarsi black from the tip of the first joint, which is pale yellow. Calypteres and halteress yellow, cilia of the former yellowish.

Wings (fig. 183) grayish; costa without an enlargement at tip of first vein; last section of fourth vein bent beyond its basal third; third vein nearly parallel with fourth; hind margin of wing scarcely indented at tip of fifth vein; anal angle prominent but rounded.

Female.—Face a little wider than in the male, yellowish gray; cilia of the calypters, anterior coxae, antennae and wings about as in the male; fore and middle tarsi a little shorter, fifth joint of the former not at all compressed, as long as third, the fourth being shorter as in the male; middle basitarsi without a bristle above, but it has a very small one below (the bristle on upper side may have been broken off, but I do not think so).

Described from 1 pair taken at Little River, Newfoundland, July 18, by P. G. Bolster.

Holotype and allotype.—In the collection of C. W. Johnson.

No. 184. DOLICHOPUS TONSUS Loew.

Dolichopus tonsus Lowe, Neue Beitr., vol. 8, 1861, p. 16; Mon. N. Amer. Dipt., pt. 2, 1864, p. 47.—Aldrich, Cat. N. Amer. Dipt., 1905, p. 301.—Melander and Brues, Biol. Bull., vol. 1, 1900, p. 148.—Johnson, Insects of New Jersey, 1909, p. 756.

Male.—Length 6 mm.; of wing the same. Face rather narrow, pale golden yellow, more whitish on the lower part. Front green, somewhat shining. Antennae wholly black; third joint about as long as wide, pointed at tip. Lateral and inferior cilia yellowish, about seven of the upper cilia on each side black.

Thorax green; dorsum with white pollen along the front and central portions, which always leaves a median, shining vitta which is often coppery and sometimes with copper spots on the sides; pleurae dulled with white pollen. Abdomen green with coppery reflections; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black; its lamellae large, somewhat elliptical, but tapering into the stem, whitish with broad black border on apical margin; jagged and bristly at lower corner, above this fringed with pale hairs to about middle of upper edge; from that to the base the hairs are black.

Fore coxae yellow, clothed on anterior surface with minute yellow and black hairs; sometimes they are mostly yellow and at others mostly black. Middle and hind coxae black with yellow tips, femora and tibiae vellow. Middle and hind femora each with one preapical bristle, the latter without cilia below, but with a row of little yellow hairs on lower inner edge, which are not longer than the hairs on upper edge. Middle tibiae with three bristles below, one pair at apical third and one bristle at basal third, their basitarsi with a large bristle above; posterior tibiae scarcely thickened; the glabrous stripe on upper surface poorly defined. Fore tarsi (fig. 184a) about one and two-thirds times as long as their tibiae; second joint two-thirds as long as first; third, fourth, and fifth of nearly equal length and each a little shorter than the second; fourth and fifth joints much conpressed; fourth white, silvery on the sides, nearly half as wide as long; fifth joint black, a little wider than the fourth, with a silky luster on the sides. Middle tarsi about one and one-fourth times as long as their tibiae, infuscated from the tip of the first joint, still only the tips of the joints black. Hind tarsi black from the base of the second joint, but sometimes colored about like the middle ones. Calypters, their cilia, and the halteres vellow.

Wings (fig. 184) grayish; costa not enlarged at tip of first vein; last section of fourth vein bent near its basal third; hind margin of wing slightly flattened between the apex and tip of fifth vein, scarcely indented at tip of fifth vein; anal angle a little prominent, but the wing narrowing from tip of sixth vein to the anal angle.

Redescribed from 7 males. J. M. Aldrich has specimens from Clementon, New Jersey, taken May 30 (Johnson); Woods Hole, Massachusetts (Hough); and from Lafayette, Indiana, taken May 25. I had specimens taken at Great Falls, Virginia, May 9-June 28. W. T. Davis took it at Wyandarch, Long Island, New York, May 25.

Type locality.—Washington, District of Columbia. Melander and Brues report it from Massachusetts; Johnson from Clementon, New

Jersey, May 30, and Riverton, New Jersey, May 30.

This differs from eudactylus in not having cilia on the hind femora, and it has the last three joints of fore tarsi equal, while eudactylus has the firth distinctly the shortest; the hind margin of the wing in tonsus is also more sinuous.

No. 185. DOLICHOPUS EUDACTYLUS Loew.

Dolichopus eudactylus Loew, Neue Beitr., vol 8, 1861, p. 16; Mon. N. Amer. Dipt., pt. 2, 1864, p. 46.—Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 11, pl. 1, fig. 2 (the figure is incorrect).—Johnson, Insects of New Jersey, 1909, p. 757.

Male.—Length 6-7 mm.; of wing 6-6.5 mm. Face rather narrow, ocher yellow or golden yellow, more whitish below. Front shining green, all the lower part covered with coarse yellowish brown pollen which is only visible in certain lights. Antennae wholly black; the first joint sometimes appears yellowish because of the pollen on under side; third joint about as long as wide, pointed at tip. Lateral and inferior orbital cilia yellowish, about six of the upper cilia black.

Thorax shining green; dorsum dulled a little with white pollen on the anterior portion; usually there is a coppery spot on each side; pleurae dulled with white pollen. Abdomen green, usually with coppery reflections; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black; its lamellae (fig. 185) large, somewhat elliptical, but narrowing in the stem, whitish with wide black border on apical margin, which is jagged and bristly on its lower portion; above this they are fringed with yellowish hairs, except at base, where the hairs are black; they are nearly twice as long as wide.

Fore coxae yellow, anterior surface covered with little black hairs. Middle and hind coxae black with yellow tips; femora and tibiae yellow. Middle and hind femora each with one preapical bristle; lower inner edge of hind femora ciliated from the middle nearly to the tip with yellow hairs, which are nearly as long as the width of the femora. Middle tibiae with three bristles below, one pair near apical third and one bristle near basal third. Posterior tibiae scarcely thickened. Fore tarsi (fig. 185a) nearly one and two-thirds imes as long as their tibiae; first three joints slender, yellow; second joint from two-thirds to three-fourths as long as first; third and fourth of nearly equal length, each more than three-fourths as

long as second; fourth and fifth joint compressed and widened; fourth white, fifth black, distinctly shorter than fourth, oval, both with little black hairs on upper edge. Middle tarsi about one and a fourth times as long as their tibiae, infuscated from the tip of the first joint, still the bases of the joints are more or less yellow, their tips black or brown; middle basitarsi with a large bristle above. Hind tarsi black from the tip of the first joint. Calvoters, their cilia, and the halteres vellow.

Wings gravish; costa scarcely enlarged at tip of first vein; hind margin of wing flattened a little from the apex of the wing to tip of fifth vein, where it is a little indented; last section of fourth vein bent near its basal third; anal angle rather prominent, but rounded.

Female.—Face wide, covered with whitish pollen; fore tarsi plain. about one and a fourth times as long as their tibiae, colored about like the middle ones in the male, fifth joint nearly as long as the third, fourth a very little shorter; hind femora without cilia; wings more evenly rounded on the hind margin, without costal enlargement.

Redescribed from many males. The collection of J. M. Aldrich has specimens taken at Battle Creek, Michigan; Ithaca, New York, June 7: Agricultural College, Michigan, June 10: Lafavette, Indiana, June 2-July 11. I have taken it at Olcott, New York, July 4: Erie County, New York, June 4-July 22; Ridgeway, Ontario, June 29-July 15; and Chatham, Ontario, June 17.

Type localities.—New York and Massachusetts. Aldrich reports it from Kansas; Johnson from Riverton, New Jersey, July 3; Woodbury, New Jersey, June 7.

No. 186, DOLICHOPUS VERSUTUS, new species.

Male.—Length 6-6.5 mm.; of wing 5-5.5 mm. Face narrow, pale golden vellow, more whitish below. Front green, sometimes coppery, shining. Antennae almost wholly black, usually a very little brownish, reddish, or even yellowish on the lower apical corner of the first joint: third joint scarcely longer than wide, the tip distinctly pointed. Lateral and inferior orbital cilia yellow, about seven of the upper cilia on each side black.

Thorax shining green; dorsum dulled a little with white pollen: along the front, on the central part, the dorsum has the pollen more brown and it is almost invisible except when viewed from the side. sometimes with coppery reflections, which form vittae or spots on the dorsum; pleurae a little dulled with whitish pollen. Abdomen green, shining, with coppery reflections; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black; its lamellae large and formed as in eudactylus; twice as long as wide. whitish with a black border, jagged and bristly on lower half of apical end, otherwise the lamellae are fringed with yellowish white hairs, except at base above where there are a few black ones.

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Fore coxae yellow, their anterior surface with small black hairs and a few very delicate yellow ones along the outer edge. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter ciliated with long yellow hairs on central portion of the lower inner edge, the longest hairs being considerably longer than the width of the femora. Middle tibiae with three bristles below, one pair near apical third and one bristle near basal third, their basitarsi with one large bristle above. Posterior tibiae distinctly thickened; the glabrous stripe on upper surface reaching nearly their whole length, inner surface with a broad glabrous space extending two-thirds their length and not reaching base or tip.

Fore tarsi (fig. 186a) about one and three-fourths times as long as their tibiae; first three joints slender, yellow, second about two-thirds as long as first, third three-fourths as long as second and a little longer than fourth, as long or slightly shorter than fifth joint; fourth and fifth joints much compressed and widened, fourth white with a silvery luster on the sides, fringed above with minute black hairs and usually with several on outer side; fifth joint black, a little wider than fourth, somewhat oval, but straight below, two-thirds as wide as long, a little longer than the fourth, fringed above with black hairs. Middle tarsi one and a third times as long as their tibiae; middle and hind tarsi infuscated from the tip of first, or base of second joint, but only the last two joints black. Calypters, their cilia, and the halteres yellow.

Wings (fig. 186) grayish; costa moderately enlarged at tip of first vein; last section of fourth vein bent near basal third; hind margin of wing scarcely indented at tip of fifth vein; anal angle rounded, but a little prominent.

Female.—Face wide, grayish white; fore tarsi plain; a little longer than their tibiae, yellowish with only the last joint black; bristle on middle basitarsi near its middle; costa without enlargement; hind femora without cilia below.

Described from many males and females. The collection of J. M. Aldrich has males from Woods Hole, Massachusetts, taken September 25 (Hough), and from Lafayette Indiana, taken June 11-July 4. C. W. Johnson has males from Niagara Falls, New York, June 24; Mathias Point, Virginia, May 22; Popes Creek, Maryland, May 22; Fall River, Massachusetts, June 17, and Manomet, Massachusetts, July 27. I have taken it at Ridgeway, Ontario, June 18-July 15.

Type.—Male, Cat. No. 23055, U.S.N.M., from Ridgeway, Ontario.

No. 187. DOLICHOPUS DAKOTENSIS Aldrich.

Dolichopus dakotensis Aldrich, Kansas University Quarterly, vol. 2, 1893, p. 11, pl. 1, fig. 1.

Male.—Length 6 mm.; of wing the same. Face narrow, golden yellow, a little more whitish below. Front shining green. Antennae wholly black or nearly so; third joint scarcely longer than wide, somewhat conical in outline, obtusely pointed at tip. Lateral and inferior orbital cilia yellow, four or five of the upper cilia on each side black.

Thorax green, with considerable white pollen on the front of the dorsum, the pollen on the center of the dorsum is more brownish and leaves a rather broad median vitta which is more shining and sometimes coppery; pleurae dulled with white pollen. Abdomen green, with black incisures and coppery reflections; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black; its lamellae (fig. 187a) large, somewhat elliptical, twice as long as wide, whitish with rather wide black apical border, jagged and bristly at lower corner, otherwise fringed with yellowish hairs.

Fore coxae vellow, anterior surface with minute vellow hairs. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter ciliated with rather scattering whitish hairs for nearly their entire length, the longest of which are scarcely as long as the width of the femora. Posterior tibiae thickened, inner surface with a broad glabrous space, extending from the base nearly to the tip. Fore tarsi (fig. 187b) twice, or sometimes more than twice, the length of their tibiae; second joint scarcely two-thirds as long as first, third and fourth of nearly equal length, each about two-thirds as long as second, and three-fourths as long as fifth; first and second, slender, yellow; third and fourth compressed, silvery white, widening from the base of third to tip of fourth; fifth much compressed, black. two-thirds as wide as long. Middle tarsi longer than their tibiae, infuscated from the tip of the first joint, still with the bases of the second and third ones paler, only their tips black. Hind tarsi black from the tip of the first joint, but sometimes colored like the middle Calypters, their cilia, and the halteres yellow.

Wings (fig. 187) grayish; costa distinctly enlarged at tip of first vein, this enlargement tapering into the costa, but not reaching half the distance to the tip of second vein; last section of fourth vein a little bent near its basal third; hind margin of wing scarcely indented at tip of fifth vein, a little flattened from the apex of the wing to the tip of the fifth vein, expanding basally from fifth vein, then narrowing to tip of the sixth vein; anal angle prominent.

Female.—Face wide, white; fore tarsi plain, last two or three joints black, fifth joint longer than fourth, nearly as long as third; hind

femora without cilia below; costa without enlargement. Middle tibiae with three bristles below, one at basal, two at apical third, their basitarsi with one large bristle above.

Redescribed from the type material and 10 males. The type specimens were taken at Brookings, South Dakota, June 16, 1891; there are 2 other males in the collection of J. M. Aldrich, 1 taken at Quebec, June 10, 1906, by Beaulieu, the other in Polk County, Wisconsin, in July, by Baker. I have taken males at Rochester, New York, May 29; Fort Erie, Ontario, June 6-July 4; and at Ridgeway, Ontario, June 18, 29.

Types.—In the collection of J. M. Aldrich.

No. 188. DOLICHOPUS PALAESTRICUS Loew.

Dolichopus palaestricus Lobw, Cent., vol. 5, 1862, No. 84; Mon. N. Amer. Dipt., pt. 2, 1864, p. 328.—Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 10, pl. 1, fig. 3.—Melander and Brues, Biol. Bull., vol. 1, 1900, p. 148.

Male.—Length 4.5-5.5 mm.; of wing 4.5 mm. Face rather narrow, golden yellow or yellowish white. Front green or blue-green, sometimes with coppery reflections. Antennae wholly black or nearly so; third joint scarcely longer than wide, somewhat conical in outline, obtuse at tip. Lateral and inferior orbital cilia yellow, about five of the upper cilia on each side black.

Thorax shining green; dorsum with a little white pollen along the front, sometimes with a median coppery vitta and a coppery spot on each side; pleurae dulled with white pollen. Abdomen shining green with slight coppery reflections. Hypopygium black; its lamellae large, nearly twice as long as wide, somewhat elliptical, whitish with broad black border on apical margin, which is jagged and bristly on lower half, above this they are fringed with yellow hairs and a few black hairs near the base above.

Fore coxae yellow, with minute black hairs on their anterior surface, middle and hind coxae black with yellow tips. Femora and tibiae yellow, middle and hind femora each with one preapical bristle, the latter ciliated on lower inner edge with rather scattering yellow hairs, which commence near the middle of the femora and reach nearly to their tips, the longest hairs nearly as long as the width of the femora. Middle tibiae with three or four large bristles below, one pair at apical third and one bristle at basal third, sometimes with another bristle between these, their basitarsi with one large bristle above. Posterior tibiae considerable thickened; inner surface glabrous for two-thirds their length, the usual glabrous stripe on upper surface distinct but a little broken. Fore tarsi (fig. 188a) one and three-fourths times as long as their tibiae; first two joints together about equal to their tibiae in length; second joint a little more than half as long as first and nearly as long as third and fourth

taken together; fourth only slightly shorter than third, fifth a little longer than third and fourth together; first two joints slender, yellow, still with slight whitish reflections; third and fourth joints compressed and widening from base of third to tip of fourth joint, whitish with distinct silvery reflections; fifth joint black with silvery reflections on outer and yellowish or reddish on inner surface, much compressed and widened, two-thirds as wide as long, somewhat pear-shaped in outline. Middle tarsi one and a fourth times as long as their tibiae, black from the tip of the first joint, still the second and even the third yellowish with only their tips black. Hind tarsi normally wholly black, but sometimes the first joint is yellowish at base, which c lor may even extend nearly to its tip, becoming darker and shading into black. Calypters, their cilia and the halteres yellow.

Wings (fig. 188) grayish; costa with a small elongated enlargement at tip of fifth joint; last section of fourth vein a little bent just beyond its basal third; hind margin of wing a very little indented at tip of fifth vein, a very little flattened from the apex of the wing to tip of fifth vein; anal angle prominent.

Female.—Face whitish, wide; fore tarsi plain, first joint as long as the two following joints together, third only a little shorter than second, fourth and fifth of equal length; yellowish, becoming darker toward the tip, but only the last joint black; hind femora and tibiae normal; wing without an enlargement of the costa, otherwise about as in the male.

Redescribed from about 50 males and several females. lection of J. M. Aldrich has specimens from Dover, New Jersey, June 8; Waubamic, Perry Sound, Ontario (Parish) June 11; and, from Franconia, New Hampshire (Mrs. Slosson). I have them from Bratton Woods, New Hampshire, June 30; Lewiston, New York, May 30; Olean, New York, August 5; Ottawa, Canada, July 2; and from the following places in Ontario, Canada: Niagara Falls, June 10; Ridgeway, June 6-July 15; Toronto, July 4; Kearney, July 2-8; Danbury, June 16.

Type.—In Museum of Comparative Zoology, Cambridge, Mass., from New Hampshire.

No. 189. DOLICHOPUS BATILLIFER Loew.

Dolichopus batillifer Lorw, Neue Beitr., vol. 8, 1861, p. 19; Mon. N. Amer. Dipt., pt. 2, 1864, p. 45.—MELANDER and BRUES, Biol. Bull., vol. 1, 1900, p. 148.—Johnson, Insects of New Jersey, 1909, p. 757.

Male.—Length, 6 mm.; of wing, 5-5.5 mm. Face narrow, golden yellow, a little more whitish below. Front green, only slightly dulled with white pollen. Antennae wholly black, or very nearly so; third joint scarcely longer than wide, somewhat conical in outline. Lateral and inferior orbital cilia yellow, about eight of the upper cilia on each side black.

Thorax bright shining green; still it has considerable white pollen on the dorsum, especially along the front, and it leaves three shining vittae, which are more or less coppery; sometimes the posterior portion of the dorsum and the scutellum is more blue or violet. Abdomen green with coppery reflections; the white pollen on its sides abundant. Hypopygium black; its lamellae rather large, whitish with wide black border on their apical margin, which is jagged and bristly onlower half, fringed above this with yellowish hairs; they are somewhat triangular in outline, but broadly rounded on upper corner.

Fore coxae yellow, anterior surface covered with little black hairs; middle and hind coxae black with yellow tips; femora and tibiae yellow; middle and hind femora each with one preapical bristle, the latter, ciliated on the central half of lower inner edge with dense yellow hairs, which are not as long as the width of the femora. Middle tibiae with four bristles below, one at basal and two at apical third and one between these, their basitarsi with a large bristle above near apical third. Posterior tibiae thickened, especially in the middle; inner surface glabrous for more than half their length and a little excavated on this portion, fringed below with an irregular row of Fore tarsi (fig. 189) about one and a half times as long as their tibiae; first three joints normal, yellow, fourth white, fifth black; first joint nearly as long as the two following taken together, third one-third as long as second and a little longer than fourth, a very little widened at tip; fourth and fifth joints compressed, fourth widening at tip, apical edge brownish, fifth a little longer than the third and fourth together, somewhat pear-shaped in outline, twothirds as wide as long, with a minute fringe of white hairs on apical edge; fourth and fifth joints fringed above with black hairs, fifth with a silky luster on the sides, which varies from black to silvery according to the angle from which it is viewed. Middle tarsionly a little longer than their tibae, black from the tip of the first joint. Usually the hind tarsi are black from the extreme tip of the first joint, but sometimes the whole of first and bases of following joints are yellow. Calypters, their cilia and the halteres yellow.

Wings a little grayish; costa with an elongated enlargement at tip of first vein; last section of fourth vein bent a little beyond its basal third; hind margin of wing slightly indented at tip of fifth vein: anal angle quite prominent, still cut off from a point a little beyond the tip of sixth vein, scarcely rounded, but somewhat flattened in outline.

Female.—Face wide, yellowish white; fore tarsi plain, a little longer than their tibiae, infuscated from the tip of the first joint, still the joints following yellowish at base, fifth joint as long as third, fourth shorter; costa without an enlargement; hind margin of wing rather evenly rounded, the anal angle being rounded, still rather prominent.

Redescribed from 3 males and several females. The males are from the following places: Big Stone City, South Dakota, taken by J. M. Aldrich; Franconia, New Hampshire, taken by Mrs. Slosson; I took 1 at Portage, New York, July 1, 1917.

Type localities.—Illinois, and West Point, New York. Melander and Brues report it from Massachusetts; Johnson from New Jersey. Types.—In Museum of Comparative Zoology, Cambridge, Massachusetts.

If we compare the six forms, palaestricus, batillifer, dakotensis, tonsus, eudactylus and versutus, which have just been described, we find them divided into two groups, one having the fore tarsi gradually compressed and widened from the base of the third joint to the tip of the fourth, these two joints being white; the fifth joint is much compressed and wider, black; this group contains batillifer Loew, palaestricus Loew, and dakotensis Aldrich; in the first two of these the fourth joint of fore tarsi is less than half as long as the fifth, while in dakotensis the fourth is three-fourths as long as fifth; in all three of these species the fifth joint is very large and about the same size and shape; these three also have the cilia of the hind femora as long or scarcely as long as the width of the femora; palaestricus is separated from batillifer by the color of the posterior tarsi, which are black nearly or quite to their base in palaestricus: still sometimes the first joint is largely yellowish, but the yellow shading into the black is not sharply defined, while in batillifer the first joint is yellow with the tip sharply black, or rarely almost wholly yellow; in batillifer the cilia of hind femora are dense and occupy the center of the femora, while in palaestricus they are more scattering and extend nearly to their tips; the glabrous surface on inner side of hind tibiae in this form extends about two-thirds of their length, while in batillifer it reaches only about half their length; the third and fourth joints of fore tarsi are not so wide in batillifer as in palaestricus. The other three forms have the third joint normal, the fourth joint much compressed and wide, and it is white, the fifth joint still more expanded and black; tonsus has the lower surface of the hind femora without cilia, while in the other two it has long yellow cilia; this form also has the fourth and fifth joints of fore tarsi of nearly equal length; eudactylus and versutus are separated, first, by the cilia of the hind femora, which are longer than the width of the femora in versutus and scarcely as long as the width of the femora in eudactylus; second by eudactulus having the third and fourth joints of fore tarsi of nearly equal length and the fifth joint distinctly shorter, while in versutus the third and fifth are nearly equal in length and the fourth is distinctly shorter than either of these.

No. 190. DOLICHOPUS TENER Loew.

Dolichopus tener Loew, Neue Beitr., vol. 8, 1861, p. 17; Mon. N. Amer. Dipt., pt. 2, 1864, p. 49.—MELANDER and BRUES, Biol. Bull., vol. 1, p. 148.

Male.—Length 4-5 mm.; of wing 3.5-5 mm. Face rather narrow, pale yellow. Front shining green, but in certain lights appearing to be covered with gray pollen which nearly conceals the ground color. Antennae yellow, third joint a little longer than wide, pointed at tip, usually a little blackened there. Lateral and inferior orbital cilia pale yellow, only three or four of the upper cilia on each side black.

Thorax light green; dorsum dulled with gray pollen; in my specimens there are two narrow coppery lines in the center with a narrow green line between them; pleurae dulled with white pollen. Abdomen green with coppery reflections; the lower edges of the dorsum with white pollen and long yellow hairs, which are longest on the second segment. Hypopygium black; its lamellae of moderate size, somewhat round in outline, white with very narrow black border on apical and upper margins, jagged and bristly at apex, fringed above with black hairs.

Coxae yellow; anterior surface of fore coxae with silvery pollen and minute white hairs; middle pair with a small brown spot on outer surface, femora and tibiae vellow. Middle and hind femora each with one preapical bristle, the latter ciliated on lower inner edge with from six to ten delicate yellow hairs, the longest of which is longer than the width of the femora, and near its middle. Middle tibiae with one small bristle below, their basitarsi without a bristle above. Posterior tibiae only slightly thickened; the usual glabrous stripe on upper surface extending from the base to apical third. Fore tarsi (fig. 190a) nearly twice as long as their tibiae, second joint three-fourths to four-fifths as long as first, third three-fourths to fully as long as second, fourth and fifth of nearly equal length, each about one-third or less than one-third as long as third; first four joints very slender, yellow, fourth a very little widened at tip; fifth black, compressed, oval, but straight below, not as wide as long. Middle tarsi nearly one and a half times as long as their tibiae, infuscated from the tip of the first joint. Calypters, their cilia, and the halteres yellow.

Wings (fig. 190) grayish; veins yellowish; costa with a small elongated enlargement at tip of first vein; last section of fourth vein moderately bent before its middle; hind margin of wing scarcely indented at tip of fifth vein, rather evenly rounded, the anal angle being rounded off, nearly obsolete.

Redescribed from 4 males which I took on Grand Island, Erie County, New York, August 17, 1913, and August 18, 1917.

Type locality.—Chicago, Illinois; Melander and Brues report it from Wisconsin.

Type.—In museum of Comparative Zoology, Cambridge, Massachusetts.

No. 191. DOLICHOPUS SICARIUS, new species.

Male.—Length 5 mm.; of wing the same. Face long and rather wide, only a little narrowed below, silvery white, slightly tinged with yellow above. Front blue-green, with a little brownish pollen. Antennae (fig. 191a) black, first joint broadly yellow below, being more than half yellow; third joint a little more than twice as long as wide, pointed at tip; arista inserted near the middle of the upper edge. Lateral and inferior orbital cilia whitish, about seven of the upper cilia on each side black.

Thorax green with blue and bronze reflections; somewhat dulled with gray pollen; pleurae a little dulled with white pollen. Abdomen green with coppery reflections; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black; its lamellae of moderate size, somewhat triangular in outline, whitish with a black apical border, jagged and bristly at apex.

Fore coxae wholly yellow; they appear nearly bare on the anterior surface but have some very minute white hairs. Middle and hind coxae black with yellow tips, the posterior pair being half yellow. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter nearly bare below. Posterior tibiae only a little thickened; the glabrous stripe on upper surface distinct and extending inside of the inner row of large bristles, still a little broken by a few hairs. First two joints of fore tarsi wholly pale yellow and, taken together, about as long as their tibiae; the second about twothirds as long as the first and a very little compressed, its sides being nearly glabrous (last three joints missing in the type). Middle tarsi about one and a half times as long as their tibiae, infuscated from the tip of the first joint, which is without a bristle above, but with several very small ones below and a larger one on posterior surface, the two first joints, taken together, about equal to the tibiae in length. Hind basitarsi yellow, becoming brown or almost black toward its tip, remaining joints black. Calypters and halteres black, the former with black cilia, and a few pale hairs mixed with them, and in certain lights have a vellowish cast.

Wings (fig. 191) long and a little narrowed; toward their base a little grayish; veins toward the root of the wing yellow; costa without enlargement at tip of first vein; last section of fourth vein a little bent near its basal third, beyond this bend nearly straight; third vein bent backward so as to be about half as far from fourth at tip as at the bend; hind margin of wing nearly straight, notched at tip of fifth vein, and widening a little just basally from this notch; there is a very small lobe at tip of sixth vein, partly caused by the wing receding from this point to the anal angle, which is rather

prominent, although narrow. One middle tibia has one, the other two bristles below.

Described from 1 male taken at Waubamic, Ontario, June 14, by H. S. Parish.

Type.—In the collection of A. L. Melander.

This species resemble porphyrops in the form of its antennae, from which it is separated by the form of the wings, as well as the color of the hind legs and feet. Although the fore tarsi are broken off, leaving only the first two joints, it seems almost certain that they were enlarged at tip, as the second joint is already very slightly compressed; still the species is well marked by the long, narrow wings with the slight lobe at tip of fifth vein; the long third antennal joint (which by its shape suggested the name), and the yellow hind basitarsi; the latter, however, may sometimes be black almost to their base, as it often is in species where the black shades into the yellow of their base and is not sharply separated.

No. 192. DOLICHOPUS SCOPARIUS Loew.

Dolichopus scoparius Loew, Mon. N. Amer. Dipt., pt. 2, 1864, p. 70.—Wheeler, Psyche, vol. 5, 1890, p. 339.—Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 18, pl. 1, fig. 9.—Melander and Brues, Biol. Bull., vol. 1, 1900, p. 148.— Johnson, Insects of New Jersey, 1909, p. 756.

Male.—Length 5-6 mm.; of wing 5-5.3 mm. Face rather wide, silvery white, front shining green with reddish purple or blue reflections. Antennae black; first joint yellow below, sometimes only the upper edge black; third joint about as long as wide, rather rounded at tip. Lateral and inferior orbital cilia pale yellow, about eight of the upper cilia on each side black.

Thorax green with well-defined median and poorly defined lateral vittae of a reddish purple color on the dorsum, which is dulled with gray pollen, almost invisible except along the front, pleurae with grayish pollen. Abdomen green with coppery reflections; the white pollen on its sides abundant. Hypopygium black, more or less yellow at tip and on the sides, its lamellae rather large, smooth, and unusually thick; on their inner surface near the middle is a small space covered with little black hairs which reach the upper edge (these are mentioned by Wheeler as a fringe of "delicate black hairs"); these are difficult to see unless the lamellae are extended.

Fore coxae yellow with a large black spot at base on outer surface. These spots sometimes extend as a line more than half their length, their anterior surface covered with stiff black hairs. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter nearly bare below, all tibiae with numerous strong bristles; middle pair with five bristles below, their basitarsi with one large bristle above and another on the front side near it. Posterior tibiae only a

little thickened; the usual glabrous stripe on upper surface broad and reaching the tip. Fore tarsi (fig. 192a) about one and a third times as long as their tibiae, black from the extreme tip of the third joint; first joint about equal to the three following joints taken together, second half as long as first, third two-thirds as long as second and but little longer than fourth, a very little widened at tip, fourth and fifth a very little flattened, fringed on each side so as to form when taken together a somewhat elliptical tip to the tarsi; they are wholly black and the fourth joint is slightly the longest. Middle tarsi one and a third times as long as their tibiae, black from the tip of the first joint. Hind tarsi black from the extreme tip of the first joint. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 192) grayish, usually tinged with brown in front of third vein and narrowly along the posterior veins; costa without enlargement at tip of first vein; last section of fourth vein a little bent before its middle; hind margin of wing indented at tip of fifth vein; anal angle prominent.

Female.—Face wide, less silvery than in the male; fore tarsi plain, about one and a fourth times as long as their tibiae, black or infuscated from the tip of the first joint; hind margin of wing distinctly but not very much indented at tip of fifth vein. The orbital cilia of both male and female have one or two black bristles next to the proboscis.

Redescribed from 28 males and several females, taken as follows: Franconia, New Hampshire; Bretton Woods, New Hampshire, June 30; Dover, New Jersey; Erie County, New York, June 2-July 18; Bond Lake, Ontario, July 16; Port Credit, Ontario, July 15; Kearney, Ontario, July 2-7.

Type localities.—Maine and Massachusetts. Aldrich reports it from Pennsylvania and Montreal, Quebec; Melander and Brues from Illionois and Wisconsin; Johnson from Dover, New Jersey, June 23.

Type.—In Museum of Comparative Zoology, Cambridge, Massachusetts.

No. 192, DOLICHOPUS QUADRILAMELLATUS LOSW.

Dolichopus quadrilamellatus LOEW, Cent., vol. 5, 1862, No. 83; Mon. N. Amer. Dipt., pt. 2, 1864, p. 331.—Johnson, Insects of New Jersey, 1909, p. 756.

Male.—Length, 6 mm.; of wing, 5.7 mm. Face wide, scarcely narrowed below, silvery white, very slightly tinged with yellow above. Front shining green or blue-green. Antennae black; first joint black above, yellow below, sometimes mostly black and at others almost wholly yellow; third joint scarcely longer than wide, rounded at tip. Lateral and inferior orbital cilia vellowish with a large black bristle at their lower end next to the proboscis, about seven of the upper cilia on each side black.

Dorsum of thorax shining green with slight bronze reflections; pleurae dulled with white pollen. Abdomen green; the white pollen on its sides abundant. Hypopygium (fig. 193) black; its lamellae large and thick, smooth, deeply cleft so as to appear like four large smooth lamellae, each part oval, still slightly but obtusely pointed at tip, the upper or inner division is slightly darkened and bears two or three black bristles and a few pale hairs at tip.

Fore coxae yellow with a black spot at base on outer side, their front surface covered with little black hairs, except at upper outer corner where there are only delicate yellow hairs. Middle and hind coxae black with vellow tips. Femora and tibiae vellow. Middle and hind femora each with one preapical bristle, the latter nearly glabrous below, but with a few minute pale hairs on lower inner Middle basitarsi with one large bristle above near their middle and another nearly as large on anterior surface near the one on top; middle tibiae with four or five bristles below. Posterior tibiae slightly thickened; the usual glabrous stripe on upper surface broad but not conspicuous; inner surface with a small elongated glabrous spot near the middle. Fore tarsi one and one-third times as long as their tibiae; first three joints slender, yellow, still the third is a little widened and whitish; first joint about as long as the three following taken together, second scarcely half as long as first, last three joints of nearly equal length, each a little more than half as long as the second; fourth and fifth black, slightly flattened and fringed on both sides with black hairs so as to form an elliptical tip to the tarsi (as in scoparius). Middle tarsi a little longer than their tibiae, blackened from the tip of the first joint. Hind tarsi black from the tip of the first joint. Calypters and halteres yellow, the former with black oilia.

Wings grayish or yellowish gray; veins yellowish, becoming brown on apical portion of the wing; costa yellow on inner edge, not at all enlarged at tip of first vein; last section of fourth vein bent before its middle; hind margin of wing rather deeply notched at tip of fifth vein; anal angle prominent.

Female.—Face wide, white; front and orbital cilia as in the male; middle basitarsi with one large bristle above, but they seem to be without the bristle on the front surface that is found in the male; fore tarsi plain, with the last two or three joints black, fourth and fifth of about equal length; wings as in the male, except that the notch in hind margin at tip of fifth vein is smaller.

Redescribed from the single pair of type specimens; also 1 male from Massachusetts; 1 male taken at Ramsey, New Jersey, June 16; 1 male taken at Boston, Erie County, New York, July 10, 1910; and several males and females taken on Staten Island, New York, July 17, by W. T. Davis. [I took two males at Blue Ridge Summit, Pennsylvania, August 8, 1920.—J. M. A.]

Type locality.—Palisades, New Jersey, June.

This is very much like scoparius Loew, but differs greatly in the form of the lamellae of the hypopygium, still even these are alike in being very thick, smooth, and rather dark yellow, but there appear to be four lamellae in quadrilamellatus while there are only two in scoparius. The females look very much alike, but the fore tarsi are quite distinctly infuscated or black from the tip of the first joint, and the fore coxae have a large black spot at base in scoparius; while in quadrilamellatus the fore coxae are wholly yellow or nearly so and the fore tarsi are black at tip, not distinctly infuscated from tip of first joint, but usually distinctly yellow to base or even the tip of third joint.

Types.—In Museum of Comparative Zoology, Cambridge, Massachusetts.

No. 194. DOLICHOPUS LACINIATUS Cognillett.

Dolichopus laciniatus Coquillett, Canadian Entomologist, vol. 42, p. 42.

Male.—Length 5 mm.; of wing 4.75 mm. Face rather narrow, not as wide in the center as the width of the third antennal joint, silvery white, tinged a little with yellow on upper portion. Front violet or green, with a little white pollen along the orbits. Antennae black, first joint yellow below for more than half their width; third joint about as wide as long, pointed at tip. Inferior orbital cilia vellow, the black cilia descending about one-third of the eye height.

Thorax green with violet or bronze reflections; dorsum a little dulled with brown pollen, this pollen is sometimes gray, always so along the front; pleurae dulled with white pollen. Abdomen green with slight bronze reflections; the white pollen on its sides not very abundant. Hypopygium black; its lamellae of moderate size, somewhat round in outline, still with nearly a right angle at lower apical corner, whitish with moderately wide black border on apical margin, which is jagged and bristly on its lower half, fringed above with little hairs which are partly black and partly pale.

Fore coxae vellow with more or less brown at base even in front and with a rather large blackish spot at base on outer surface, in one specimen the outer surface is half blackish. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter ciliated with long yellow hairs for half their length on lower inner edge, the longest of these hairs considerably longer than the width of the femora. Middle tibiae with three bristles below, two near apical, and one near basal third, their basitarsi with one large bristle above. Posterior tibiae a little stouter than the others; the usual glabrous stripe on upper surface wide and extending their whole length, but somewhat broken at apical third by two bristles and a few hairs; inner surface with another glabrous stripe which is separated from the upper one

by a single row of hairs and extending two-thirds their length; the bristles on their lower surface nearly as large as those above. Fore tarsi (fig. 194) about one and three-fourths times as long as their tibiae, the first two joints taken together fully as long as the tibia; second joint about three-fifths as long as first, third three-fourths as long as second, fourth half as long as third, and fifth longer than fourth; fourth joint a little compressed, white, widest at tip; three first joints normal, yellow; fifth black, much compressed, somewhat oval, still a little truncate at tip, about three-fourths as wide as long; fourth and fifth joints fringed above with minute black hairs. Middle tarsi one and a third times as long as their tibiae, yellow, becoming darker from the tip of the first joint, nearly black at tip. Hind tarsi nearly as long as the middle ones and of the same color. Calypters and halteres yellow, the former with black cilia, still there are a few small yellow hairs among them and some longer ones below the black cilia.

Wings grayish; veins yellowish; costa with a small elongated enlargement at tip of first vein; last section of fourth vein bent near basal third; third and fourth veins nearly parallel and widely separated; hind margin of wing scarcely indented at tip of fifth vein; anal angle rather prominent but rounded; root of wing yellow.

Redescribed from the single male type in the United States National Museum, taken at Roxborough, Pennsylvania, June 7, 1908; 1 male taken at Dead Run, Virginia, June 23, and 1 male taken at Niagara Falls, Ontario, August 4.

Type.—Male, Cat. No. 12767, U.S.N.M.

No. 195. DOLICHOPUS OCCIDENTALIS Aldrich.

Dolichopus occidentalis Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 19, pl. 1, fig. 18.—Melander and Brues, Biol. Bull., vol. 1, 1900, p. 148.

Male.—Length 4.5-5.5 mm.; of wing 4.2-5 mm. Face pale yellow to ocher yellow, rather wide, narrowed below. Front shining green with a little yellowish pollen along the orbits. First antennal joint yellow, sometimes narrowly black above, second joint black, sometimes a very little yellowish below; third black, about as long as wide, rather rounded at tip. Lateral and inferior orbital cilia yellow, about seven of the upper cilia on each side black.

Thorax green with coppery reflections, which often form a narrow line on each side of the acrostichal bristles, sometimes there are also blue reflections on the dorsum, which is dulled with gray pollen along the front and yellowish on the disk; pleurae dulled with whitish pollen. Abdomen green with coppery reflections; the white pollen on its sides not conspicuous; the bristles on the hind margins of the segments long, especially those on fifth segment. Hypopygium black with metallic reflections on basal portion; its lamellae large.

somewhat elliptical, nearly twice as long as wide, whitish with a black border, which is wide on apical and narrow on upper margin, jagged and bristly at lower apical corner, otherwise fringed with delicate black hairs.

Fore coxae yellow with conspicuous black hairs on their anterior surface and a blackish spot at base on outer side. Middle and hind coxae black with narrow yellow tips. Femora and tibiae yellow. Middle and hind femora each with one prespical bristle, the latter without cilia below, the black hairs on their sides reaching the lower edge, leaving only a narrow glabrous line below. Middle tibiae with three bristles below, two near apical and one near basal third, their basitarsi without a bristle above. Posterior tibiae a little thickened; the usual glabrous stripe on upper surface distinct, but somewhat broken; their inner surface sometimes with a brownish streak just inside of the inner row of large bristles near the middle, Fore tarsi (fig. 195a) about one and one-third times as long as their tibiae; first three joints slender, yellow, second about half as long as first, third half as long as second; fourth joint nearly as long as third, a little widened, as wide as long, yellowish with a black tip, sometimes mostly blackish; fifth joint black, much compressed, about as long as second and third taken together, fully two-thirds as wide as long, somewhat oval but straight below, fringed on upper edge with black hairs. Middle and hind tarsi one and a third times as long as their tibiae, black from the tip of the first joint. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 195) gravish, usually tinged with yellowish or brownish in front of third vein; costa with an enlargement, commencing before the tip of first vein and gradually tapering; last section of fourth vein bent just before its middle; third vein bent backward a little at its tip; hind margin of wing scarcely indented at tip of fifth vein; wing of rather equal width, the anal angle being prominent.

Female.—Face wide; third antennal joint shorter than wide; coxae and legs as in the male; fore tarsi plain, a little longer than their tibise; fifth joint slightly longer than fourth; wing as in the male, except that the costa is not enlarged and the hind margin is more rounded, making the wing wider.

Redescribed from numerous specimens. J. M. Aldrich has taken it at Friday Harbor, Washington, May 28-July 14; Dewatto, Washington, June 7; Puyallup, Washington, June 17; and Mount Constitution, Orcas Island, Washington, July 7. A. L. Melander has taken it at several places in Washington, May 23-August 7; Hood River, Oregon, June 30; Salem, Oregon, July 4; Clayton and Abbotsford, British Columbia, August 9. H. S. Barber took it at Eureka, California, June 3, and Fieldbrook, California, May 31.

Type locality.—State of Washington.

Type.—In the collection of the University of Kansas. Melander and Brues report it from Idaho and Vancouver Island.

No. 196. DOLICHOPUS TALUS, new species.

Male.—Length 4-6 mm.; of wing 4.5-5 mm. Face rather wide, yellowish gray, nearly white below. Front shining green with bronze reflections. Antennae black, first joint yellow except the upper edge; third joint somewhat orbicular in outline, but the tip slightly pointed. Lateral and inferior orbital cilia yellowish, about five of the upper cilia on each side black.

Thorax green; the dorsum in one male has blue, in the other coppery reflections, it is dulled with rather thin yellowish gray pollen, pleurae with gray pollen. Abdomen green with coppery reflections; the white pollen on its sides abundant. Hypopygium black; its lamellae large, somewhat elliptical in outline, but narrowing into the stem, twice as long as wide, whitish with a broad black border on apical and upper margins, jagged and bristly on lower apical corner, otherwise fringed with little black hairs.

Fore coxae yellow, a little darker at base, their anterior surface covered with white pollen and stiff black hairs. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter without cilia, but their lower edge with minute yellow hairs. Posterior tibiae only a little thickened; the glabrous stripe on upper surface distinct, but a little broken by a few hairs. Fore tarsi (fig. 196a), about one and three-fourths times as long as their tibiae; first three joints a little compressed but not widened except at tip of third, glabrous on the sides, which are covered with white pollen; first joint yellow with extreme tip and a line on upper and lower edges black; last four joints black; second joint fully two-thirds as long as first, third two-thirds as long as second; fourth somewhat triangular, nearly as wide at tip as long, scarcely one-third as long as third; fifth joint much compressed, as long as third and three-fourths as wide as long, somewhat oval, fringed above with little black hairs. Middle tarsi a little longer than their tibiae, black from the tip of the first joint, which has a large bristle near spical third. Hind tarsi blackened from the tip of the first joint. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 196) grayish, sometimes tinged with yellowish brown in front of third vein; costs not enlarged at tip of first vein; last section of fourth vein bent before its middle; hind margin of wing a little indented at tip of fifth vein and with a shallow sinus between the tips of fifth and sixth veins; anal angle prominent, the wing being of nearly equal width.

Female.—Face wider than in the male but not very wide for a female, grayish white; fore tarsi plain, black from the tip of the

first joint, which is about as long as the three following joints taken together; third and fifth of nearly equal length, fourth a little shorter, third only a little shorter than second; middle basitarsi with a large bristle before its apical third, their tibiae with three bristles below, two near apical third and one a little before the middle (I can not see these bristles in the male, still they may be broken off); hind margin of wing more rounded than in the male, making the wing a little wider in the middle.

Described from 2 males and 3 females which I took in California; 1 at the foot of Portrero Grade, on Cottonwood Creek, San Diego County, April 21; the others on the Los Angeles River, Los Angeles, May 3.

Holotype and allotype.—In the United States National Museum. Type.—Male, Cat. No. 23056, U.S.N.M.

No. 197. DOLICHOPUS COQUILLETTI Aldrich.

Dolichopus coquilletti Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 19, pl. 1, fig. 17.—Melander and Brues, Biol. Bull., vol. 1, 1900, p. 148.

Male.—Length 5 mm.; of wing the same. Face moderately wide, slightly narrowed below, silvery white. Front green with bronze reflections, usually mostly bronze colored. First antennal joint yellow with a black upper edge, second and third joints black, third not much longer than wide. Lateral and inferior orbital cilia white, about eight of the upper cilia on each side black.

Thorax green; dorsum somewhat dulled with grayish pollen and usually with a median coppery vitta; pleurae with white pollen. Abdomen green with coppery reflections; the white pollen on its sides abundant and extending upon the dorsum; sides of the first segment with long, slender, bent, black hairs which sometimes appear pale in certain lights. Hypopygium black; its lamellae large, somewhat elliptical, but tapering into the stem, twice as long as wide, whitish with wide black border on apical margin, which is jagged and bristly at the lower corner, fringed above with delicate brownish hairs.

Fore coxae yellow with a small blackish spot at base on outer side, their anterior surface covered with little black hairs, except the upper outer corner, where the hairs are minute and yellow. Middle and hind coxae black with yellow tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter without cilia below, but with minute yellow hairs on lower inner edge. Fore tibiae with four large bristles above and three below. Middle tibiae with a pair of large bristles at apical third below and rarely a smaller one near basal third, their basitarsi with a large bristle above at apical third. Posterior tibiae only slightly thickened; the large bristles on upper edge rather long, the outer row with eight,

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and the inner with six bristles, the usual glabrous stripe between them broad, but a little broken by a few hairs. Fore tarsi (fig. 197a) about one and one-third times as long as their tibiae, infuscated from the tip of the first joint, still the base of the second paler, only the last two joints black; first three joints slender, second and third each two-thirds as long as the joint preceding it, fifth scarcely as long as third; fourth half as long as fifth, a little widened at tip; fifth compressed, a little widened, widest at tip where it is a little less than half as wide as long, fringed above with little black hairs; pulvilli white. Middle tarsi about one and one-fourth times as long as their tibiae, black from the tip of the first joint. Hind tarsi black from the tip of the first joint, sometimes their basitarsi are brown or even black almost to the base. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 197) grayish, a little darker in front; costa not enlarged at tip of first vein; last section of fourth vein bent before its middle; hind margin of wing a little indented at tip of fifth vein and with a slight sinus nearly opposite the cross-vein; anal angle prominent, the wing being of somewhat equal width.

Female.—Face wider than in the male; fore tarsi plain, about one and one-fourth times as long as their tibiae, colored as in the male; fifth joint about as long as third, fourth a little shorter; bristles of the tibiae about as in the male, except that there are usually three bristles below on middle tibiae; wing about as in the male, except that the hind margin is more evenly rounded, there being no trace of the sinus, and the wing a little wider in the middle.

Redescribed from 1 type, and many specimens taken in the following localities: Moscow, Bellevue, and Grangeville, Idaho, June 23-27; Hood River, Oregon, August 9; Indian School, Pyramid Lake, Nevada, July; Mono Lake, California, July 21; Seattle, Washington. All the above were taken by J. M. Aldrich. Thompson took a male at Woodside, California, April 15. C. F. Baker took it in Colorado-A. L. Melander took it in many places in Washington, May 15-August 15, and at Kermeos, British Columbia, July 19.

Type locality.—California. J. M. Aldrich reports it abundant at Moscow, Idaho. Melander and Brues report it from Vancouver Island.

Type.—In collection of J. M. Aldrich.

The only difference I can see between the females of coquilletti and talus is that the former has the third vein only slightly bent backward at its tip, while in talus the third vein is distinctly bent back at its tip; this is a poor character to depend on, as it may vary some in both species.

No. 198. DOLICHOPUS PLUMOSUS Aldrich.

Dolichopus plumosus Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 18, pl. 1,

Male.—Length 4.5-5 mm.; of wing 4.5-4.75 mm. Face moderately narrow, pale yellow, sometimes almost golden yellow. Front shining green. First two antennal joints yellow, second narrowly black at tip; third joint black, somewhat conical in outline, pointed at tip, about as long as wide. Lateral and inferior orbital cilia vellowish, about six of the upper cilia on each side black.

Thorax green with coppery reflections; dorsum a little dulled with gray pollen, which is more or less yellowish brown on the disk; pleurae dulled with white pollen. Abdomen green with more or less coppery reflections; the white pollen on its sides extending upon the dorsum but not conspicuous. Hypopygium black with green reflections on basal half; its lamellae large, nearly twice as long as wide, somewhat elliptical in outline, but narrowing into the stem, white or yellowish with a black border, which is broad on apical, narrow on upper margin, jagged and bristly at apex, fringed with black hairs above and a few pale ones below.

Fore coxae vellow, usually wholly so, their anterior surface covered with white pollen and delicate little yellow hairs with a few black ones along inner and outer edges. Middle and hind coxae blackish with yellow tips. Femora and tibiae yellow. Fore femora with long black hairs on upper edge of basal half, the longest being nearly as long as the width of the femora; they also have long black hair on apical half of posterior side; these are sometimes vellowish. Middle and hind femora each with one preapical bristle, and with delicate little yellow hairs on the lower edge, the hind pair without cilia below. Middle tibiae with a pair of bristles below near apical third and usually with a smaller one near basal third, their basitarsi with a bristle near apical fourth. Posterior tibiae thickened in the middle. their inner surface entirely covered with black hairs. Fore tarsi (fig. 198a) one and a half times as long as their tibiae, sometimes blackened from the tip of the first joint, in others the first three joints are yellow with black tips, last two joints always black; first joint three-fourths as long as the tibiae, second half as long as first, third half as long as second, slightly widened at tip; fourth joint shorter than third, a little compressed, about as wide as long; fifth joint compressed, nearly as long as third and fourth taken together, about two-thirds as wide as long, somewhat oval, but truncate at tip, fringed above with black hairs; empodium white, plume-like, forming a white tip to the tarsi. Middle tarsi a little longer than their tibiae, black from the tip of the first joint. Hind tarsi black, usually the first joint is mostly yellow with only the tip black, but sometimes it

is blackened almost to the base. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 198) grayish, the front slightly darker; costa with a very small enlargement at tip of first vein; last section of fourth vein a little bent before its middle; hind margin of wing a little indented at tip of fifth vein and with a small sinus each side of the tip of sixth vein, leaving a slight lobe at the tip of sixth vein, somewhat narrowed from here to the anal angle, which is prominent but narrow.

Female.—Face wide, grayish white; fore coxae with more black hairs than in the male; fore tarsi plain, a little longer than their tibiae, infuscated from the tip of the first joint; fifth joint nearly as long as third, fourth distinctly shorter; fore femora with a few longer hairs at base of upper edge but they are much shorter than in the male; wings nearly evenly rounded on the hind margin; anal angle prominent but rounded off.

Redescribed from 11 males and 10 females taken in the State of Washington from June 19-July 23; they were taken at Olga and Friday Harbor by J. M. Aldrich and at Olympia by Prof. Trevor Kincaid. Also 6 males taken by A. L. Melander, one at Dewatto, Washington, Aug. 15, and the others at Lake Crescent, Piedmont, Washington, July 26.

Type.—In University of Kansas, from the State of Washington.

No. 199. DOLICHOPUS AINSLIEI, new species.

Male.—Length 5 mm.; of wing the same. Face rather wide, a little narrowed below, silvery white. Front green, not very bright. Antennae yellow; third joint mostly olackish, somewhat orbicular in outline, rather rounded at tip. Lateral and inferior orbital cilia yellowish, about seven of the upper cilia on each side black.

Thorax green with more or less bronze reflections, which form a median vitta on the dorsum in some specimens; dorsum dulled with rather thick gray pollen, which is often more brownish on the disk; pleurae dulled with white pollen. Abdomen green with coppery reflections, dulled with grayish pollen. Hypopygium black; its lamellae (fig. 199a) rather small, somewhat elongate oval, but rather pointed at tip, about two and a half times as long as wide, white with a black border on apical margin, very narrowly black on upper edge, jagged and bristly at tip, fringed above with a few black hairs.

Coxae yellow, middle ones a little blackened on outer side; fore coxae with silvery pollen and delicate little yellow hairs on the anterior surface; sometimes there are a few very minute black ones on inner edge. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, ciliated on lower inner edge with a few delicate white hairs, which are nearly as long as width of femora. Posterior tibiae thickened; the usual glabrous stripe on upper surface distinct but somewhat broken, their inner surface glabrous for

more than half their length. Fore tarsi (fig. 199b) about one and a half times as long as their tibiae; first and second joints yellow, normal, second three-fourths as long as first; last three joints compressed, third and fourth black, fifth white; fourth joint about half as long and not as wide as third, third and fourth fringed above with black hairs; fifth joint slightly longer than fourth, oval. Middle tarsi one and a third times as long as their tibiae, infuscated from the tip of the first joint, still the most of second and fifth joints are yellowish, fifth half as long as fourth. Hind tarsi about one and a fourth times as long as their tibiae, infuscated from the tip of the first joint. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 199) tinged with yellowish in front of third vein, sometimes only slightly so; costa with a conspicuous elongated enlargement at tip of first vein; last section of fourth vein a little bent near its basal third; hind margin of wing scarcely indented at tip of fifth vein, but with a sinus between the tip of sixth vein and the anal angle so as to form a prominent lobe at anal angle.

Female.—Agrees with the male in width of the face, form of the antennae, and in general color; the fore coxae have more black hairs than those of the male; fore tarsi plain, about one and a third times as long as their tibiae, infuscated from the tip of the first joint; hind margin of the wing rather broadly and evenly rounded, the anal angle being rounded, although rather prominent. The fore tibiae have a narrow glabrous line on upper surface, which is not found in the male.

Described from 3 males and 3 females. Two males were taken at Olmstead, Minnesota, June 15, 1905, by C. N. Ainslie, in whose honor they are named; and 1 male and the females which I took at Irving, Eric County, New York, Aug. 26, 1917.

Type.—Male, Cat. No. 23057, U.S.N.M., from Minnesota.

No. 200. DOLICHOPUS FUNDITOR Loew.

Dolichopus funditor LOEW, Neue Beitr., vol. 8, 1861, p. 22; Mon. N. Amer. Dipt., pt. 2, 1864, p. 66.—Aldrich, Kansas University Quarterly, vol. 2, 1893, p. 20, pl. 1, fig. 10.

Male.—Length 4-5 mm.; of wing 4.3 mm. Face narrow, a little wider above, silvery white. Front shining green, usually with blue reflections. Antennae yellow; third joint scarcely infuscated at tip, a little longer than wide, pointed at tip. Lateral and inferior orbital cilia yellowish white, about five of the upper cilia on each side black.

Thorax green with blue or purple reflections; dorsum dulled with gray or yellowish gray pollen; the humeri, sides of the scutellum, and sutures of the pleurae yellow. Abdomen green with slight bronze reflections; the white pollen on its sides not very abundant. Hypopygium black, with its upper side more or less yellow; its lamellae of

moderate size, somewhat orbicular in outline, white with moderately wide black border on apical and upper margins, jagged and bristly at apex, fringed above with delicate little black hairs.

All coxae yellow; fore coxae with delicate white hairs on their anterior surface, middle pair also with white hair, except a few black ones at tip. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter ciliated on lower inner edge with white hairs, which are about three-fourths as long as the width of the femora and do not reach the tip; they are of nearly equal length. Middle tibae with three bristles below, two near apical third and one bristle near basal third, their basitarsi with a rather small bristle above. Posterior tibiae scarcely thicker than the others, their inner surface with a glabrous space extending from near the base to beyond their middle. Fore tarsi one and three-fourths times as long as their tibiae, the first two joints together as long as the tibia; first three joints slender, yellow, of decreasing length; fourth and fifth joints compressed, fourth black, fringed above with rather long black hairs. and a little shorter than either third or fifth joints, which are of nearly equal length; fifth joint white and fringed above with white hairs. somewhat oval; middle and hind tarsi darkened toward their tips; middle pair one and a fourth, hind one and a third times as long as their tibiae. Calypters and halteres yellow, the former with black cilia.

Wings grayish, sometimes tinged with yellowish brown along the front; costa and veins yellowish brown; costa scarcely enlarged at tip of first vein; last section of fourth vein a little bent near its basal third; tips of third and fourth veins widely separated; hind margin of wing nearly evenly rounded, scarcely indented at tip of fifth vein; anal angle rounded, not prominent.

Female.—Face rather wide, yellowish gray; fore tarsi plain, one and a fourth times as long as their tibiae, darkened toward the tip, their joints of regularly decreasing length; middle basitarsi without a bristle above, hind femora without cilia below; otherwise as in the male.

Redescribed from the type material and 4 males and 1 female. One male at Merchantville, New Jersey, June 28; 1 at Philadelphia, Pennsylvania, June 30; 1 in Montgomery County, Pennsylvania, July 4; 1 at Scotts Run, Virginia, August 2; the female at Niagara Falls, New York, September 16; and 1 male at Lafayette, Indiana, June 30.

Type.—In Museum of Comparative Zoology, Cambridge, Massachusetts, from "Middle States."

No. 201. DOLICHOPUS FUNDITOR, var. DISTINCTUS, new variety.

Male.—Length 5 mm.; of wing 4.75 mm. This differs from funditor Loew in having the third antennal joint nearly twice as long as wide

and in the form of the fore tarsi; the variety distinctus (fig. 201) has the second joint two-thirds as long as first, third three-fourths as long as second and a little shorter than fourth and fifth taken together. fourth and fifth of nearly equal length, and taken together about equal to second in length, being much shorter than first; while funditor (fig. 200a) has the second three-fourths as long as first, third twothirds as long as second and about equal to the fifth in length and nearly as long as first, the fourth being shorter. The fourth is more compressed and widened in funditor than in distinctus.

These differences are not very conspicuous and may prove to be variable when more material is found, but for the present I think this form should be considered as a distinct variety of funditor, as it will be better to make this a synonym than to separate the two if they prove to be distinct.

Described from 2 males, 1 taken at Opelousas, Louisiana (Pilate, from Hough through Aldrich), and 1 at Merchantville, New Jersey (C. W. Johnson), June 28.

Type.—Male, Cat. No. 23058, U.S.N.M., from Opelousas, Louisiana.

No. 202. DOLICHOPUS WILLISTONII Aldrich.

Dolichopus willistonii Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 22, pl. 1, fig. 23.

Male.—Length 4.5-6 mm.; of wing 5-5.5 mm. Face quite wide, narrower and silvery white below, more yellowish gray above. Front shining green with blue or bronze reflections, sometimes mostly violet. Antennae yellow; third joint slightly darkened at tip, about as long as wide, pointed. Proboscis yellowish brown; palpi brown. Lateral and inferior orbital cilia whitish, three or four of the upper cilia on each side black.

Thorax green, usually with bronze or coppery reflections, sometimes mostly violet; dorsum with yellowish gray pollen, which is more abundant along the front; pleurae dulled with white pollen. Abdomen green with coppery reflections; the white pollen on its sides abundant. Hypopygium black with green reflections on the basal portion; its lamellae of moderate size, somewhat triangular in outline, but rounded at tip, longer than wide, whitish with rather wide black border on apical margin, jagged and bristly at upper apical corner, otherwise fringed on the apical margin with black hairs, lower edge with a few white hairs.

Coxae yellow; middle pair with two blackish spots on outer surface; fore coxae have on their anterior surface minute yellow hairs. except along the inner edge and near the apex where the hairs are black. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter with only very minute yellow hairs on lower inner edge. Middle tibiae with three large bristles below, two near apical and one near basal third, their basitarsi with

one large bristle above near apical third; their inner surface glabrous from the base to apical third; the usual glabrous stripe on upper surface distinct, it is somewhat broken by little hairs and does not quite reach the base but extends to the tip. Fore tarsi (fig. 202a) nearly one and three fourths times as long as their tibiae; first two normal, yellow, second about one-fourth as long as first; last three joints compressed; third joint scarcely as long as second, white, about half as wide at apex as long, fringed above with a few black hairs and with several on the sides and with two long ones at upper apical corner; fourth joint black with a white tip, a little longer than the second, nearly three-fourths as wide as long, fringed above on the black portion with long, dense, black hairs, which give it something of a triangular appearance; fifth joint formed of two parts, the lower part about equal to the fourth joint in size, nearly twice as long as wide, wholly black; upper portion as long as second and third joints taken together, a little less than half as wide as long, black with a brownish luster in certain light and with the apex silvery white, the black portion fringed above with long dense black hairs. Middle tarsi nearly one and a third, hind tarsi one and three-fourths as long as their tibiae, infuscated from the tip of the first joint, still the base of the second and third joints quite yellowish. Calypters and halteres vellow, the former with black cilia.

Wings (fig. 202) grayish, veins brown, inner half or more of the costa yellow; costa with a small enlargement at tip of first vein and tapering to its tip; third vein bent backward at tip but tips of third and fourth widely separated; last section of fourth vein a little bent near its basal third; hind margin of wing a little indented at tip of fifth vein; anal angle prominent.

Female.—Face wide, more white than in the male; fore tarsi plain, yellow, a little infuscated toward their tips, about one and a fourth times as long as their tibiae, second joint slightly more than half as long as the first; third a little shorter than the second and a little longer than the fourth; fifth about equal to the fourth in length; middle basitarsi with one or two very small bristles beyond its middle, usually without a larger bristle above, still there is sometimes a rather small bristle above beyond the middle; costa without an enlargment; third and fourth veins nearly straight beyond the bend in fourth, still the third is bent backward a little at tip.

Redescribed from the type material in the Aldrich Collection (7 specimens); also 3 males and 2 females from Lawrence, Kansas; 1 male taken at Wolfe City, Texas, May, 1906, by F. C. Bishopp; and 2 males taken by R. H. Beamer, 1 in Linn County, Kansas, and the other in Miami County, Kansas.

Type material taken in Lawrence, Kansas; part is in the University of Kansas, part in the collection of J. M. Aldrich.

No. 203. DOLICHOPUS SEXARTICULATUS Loew.

Dolichopus sexarticulatus LORW, Mon. N. Amer. Dipt., pt. 2, 1864, p. 62.— MELANDER and BRUES, Biol. Bull., vol. 1, 1900, p. 148.

Male.—Length 5-6 mm.; of wing 4.5-5.5 mm. Face rather wide, a little narrowed below; yellowish white, more yellow above. Front green with bronze reflections, sometimes more blue-green, a little dulled with yellowish pollen. Antennae yellow; third joint infuscated at tip, about as long as wide, pointed. Lateral and inferior orbital cilia yellowish, about four of the upper cilia on each side black.

Thorax green with bronze reflections and a median coppery vitta on the dorsum, which is dulled with yellowish pollen, this pollen is more gray along the front; pleurae dulled with white pollen. Abdomen green with coppery or bronze reflections; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium with its basal portion metallic green, its apical half more yellow; lamellae of moderate size, somewhat triangular, but rounded at apex, whitish with a narrow black border which shades into the white; jagged and bristly at lower apical corner, otherwise fringed on apical margin with little black hairs.

Coxae yellow; middle and hind pairs with one large and one small black spot on the outer surface; anterior surface of fore coxae with white pollen and minute yellow hairs. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter nearly bare on their lower half, which has only a few minute yellow hairs. Middle tibiae with two large bristles on lower anterior edge, their basitarsi with one rather small bristle near apical third of upper Posterior tibiae thickened, especially on basal half; the usual glabrous stripe on upper surface broad but broken by the irregular placing of the large bristles and a few hairs; inner surface excavated on basal half, which is glabrous and covered with yellow pollen. Fore tarsi (fig. 203a) twice as long as their tibiae, the first joint being four-fifths as long as the tibia; first three joints rather slender, vellow, second joint half as long as the first, third a little shorter than the second; last two joints compressed; fourth nearly threefourths as long as third, about half as wide at apex as long, wholly black, fringed above with little black hairs and with two long hairs at upper apical corner; fifth joint formed of two parts, the basal portion about as long as the fourth joint and a little wider, base deep black, a little more than apical half white, claws placed near the middle of this basal portion on its lower edge, attached to the upper apical corner of basal part is the second part, an appendage which is narrow at its base, widening apically, somewhat spatulate, deep black for a little more than half its length, with the apical part white; this appendage has the appearance of a sixth joint, it is much smaller than the basal portion, being little more than half as long and much more slender. Middle and hind tarsi infuscated from the tip of the first joint. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 203) grayish; costa scarcely enlarged at tip of first vein, still rather thick from this point to its tip; second and third veins running rather close together and both bent backward at their tips, third widely separated from fourth; last section of fourth vein a little bent just beyond its basal third; hind margin of wing scarcely indented at tip of fifth vein; anal angle rather prominent.

Female.—Face wide, grayish white; coxae, femora, and general color as in the male; fore tarsi plain, about one and a fourth times as long as their tibiae, first joint about as long as the three following joints taken together, fourth and fifth joints of nearly equal length; wing about as in the male, except that the second vein is straight and the third vein is nearly so.

Redescribed from 5 males and 3 females from Louisiana; 1 pair from Opelousas, Louisiana, 1897 (Pilate); and 1 male taken by C. T. Greene at Falls Church, Virginia, June 22.

Type locality.—District of Columbia. Melander and Brues report it from Illinois and Louisiana.

No. 204. DOLICHOPUS SPHAERISTES Brues.

Dolichopus sphaeristes BRUES, Ent. News, vol. 12, 1901, p. 44.

The following is a copy of the original description.

Bright green; antennae, except part of third joint, yellow; femora yellow; cilia of inferior orbit pale; tegular cilia black; fourth longitudinal vein not broken; hind tibiae and tarsi at base yellow; fourth and fifth joints of male fore tarsi enlarged, black, the fifth bilobed and with a large snow-white empodium.

Male.—Length 6 mm., of wing 5 mm.; bright coppery green, moderately shining. Face rather narrow, ochreous, much lighter on the lower fourth. Palpi light yellow. Antennae yellow except a black spot at insertion of the arista and the infuscation of the tip of third joint. Third joint short, oval, obtusely rounded at tip. Arista black, about one and one half times the length of the antennae, distinctly pubescent. Vertex shining green. Postocular cilia, except three upper ones pale vellow. Thorax slightly yellowish pollinose in front. Pleurae darker and white pollinose. Coxae pale yellow except a black stain on middle pair externally. Anterior ones bare except for a row of black hair along the apical external edge. Middle ones sparsely black-hairy anteriorly. Abdomen green at base and coppery posteriorly, last segment and hypopygium black. Internal appendages of hypopygium ferruginous. Lamellae gradually narrowed toward the base and obliquely arcuate at apex; white, narrowly and sharply bordered with black on the apical half; strongly bristly at the apical angle, elsewhere almost devoid of bristles; with a region of black punctures near anterior angle. Legs yellow except last two joints of anterior tarsi, which are black; and four posterior tarsi, which are gradually infuscated beyond tip of first joint. Lest two joints of anterior tarsi (fig. 204) much enlarged and fringed with black hair on anterior edge. The fifth slightly bilobed at apex, part of the joint forming a sort of appendage. Empodium very large, snow-white, almost as large as the fifth joint. Posterior tibiae greatly thickened, especially near base, as stout as the femora. Each tibia has an elongate bare space on inner side of basal half. Wings hyaline, rather narrow at base.

Costa distinctly thickened at tip of first vein, fourth not sharply angulate. Incision at tip of fifth vein well marked.

Austin, Texas, May, 1900.

This species is readily recognized by the peculiar ornamentation of the male fore tarsi and the configuration of fore [hind] tibiae. The fore tarsi approach most closely to *D. sexarticulatus* Loew, from which they differ by their very small appendages. It is a peculiar form.

I have not seen the species; the drawing was made by Mr. Cole from the type specimen in the collection of A. L. Melander.

No. 205, DOLICHOPUS TERMINALIS Loew.

Dolichopus terminalis LOEW, Cent., vol. 5, 1864, No. 78.—MELANDER and BRUES, Biol. Bull., vol. 1, 1900, p. 148.

Dolichopus germanus WHEELER, Psyche, vol. 5, 1900, p. 341.

Male.—Length 4-4.5 mm.; of wing 3.2-4 mm. Face narrow, a little wider above, silvery white. Front shining green with more or less blue reflections. Antennae yellow; third joint infuscated toward its tip, about as long as wide, obtusely pointed at tip. Lateral and inferior orbital cilia white, about six of the upper cilia on each side black.

Thorax green; dorsum sometimes with coppery reflections, which form a median vitta, and with a little gray pollen which is mostly found along the front edge; pleurae dulled with white pollen. Abdomen green with coppery reflections; the white pollen on its sides quite abundant. Hypopygium black, its basal portion with green reflections and white pollen; its lamellae rather large, somewhat oval, nearly twice as long as wide, white with a rather narrow black border on apical and upper margins, jagged and bristly at apex, which is somewhat pointed, fringed above with delicate black hairs.

Coxae wholly yellow; fore coxae with white pollen and numerous delicate white hairs on their anterior surface; middle coxae with an unusually long bristle on outer surface, it being one-third longer than that on hind coxae femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter nearly bare below, still with a few minute yellow hairs near lower edge. Middle tibiae with three bristles below, two near apical third and one just before the middle, their basitarsi with a bristle, which is not very large, on upper surface near apical third. Posterior tibiae not thickened; the usual glabrous stripe on upper surface not very distinct. Fore tarsi (fig. 205a) one and a half times as long as their tibiae, yellow with the last joint black, contrasting strongly with the pale joints preceding it and a very little compressed, scarcely as long as fourth, somewhat oval; first joint about as long as the three following joints taken together, second two-thirds as long as first, third only a little shorter than second and fully as long as fourth and fifth taken together. Middle tars; one and one-fourth times as long as their tibiae, black from the tip of the first joint. Hind tarsi black from the tip of the first joint, which is usually yellow, but sometimes more brownish yellow. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 205) grayish; costa without enlargement at tip of first vein; last section of fourth vein bent before its middle, the last portion straight; third vein bent backward at tip; hind margin of wing scarcely indented at tip of fifth vein, and nearly evenly rounded, so that the wing is somewhat narrowed at its base, the anal angle not being prominent.

Female.—Face twice as wide as in the male, silvery gray or almost white; fore tarsi about as in the male, only a little shorter and fifth joint scarcely dilated, they are a little darker in color in my specimens; middle basitarsi without a bristle above; wing about as in the male.

Redescribed from the type material of terminalis and one of the type specimens of germanus; also specimens from Algonquin, Illinois, (Nason), July 10 and 23; South Dakota; Wisconsin; Grand Island, Erie County, New York, July 23 and August 17; Tonawanda, New York, August 4; Ridgeway, Ontario, July 23-August 13.

Type locality of terminalis Genesseo, New York, and that of germanus Milwaukee County, Wisconsin (which was described from 15 males and 18 females).

Type of terminalis in Museum of Comparative Zoology, that of germanus in American Museum.

No. 206. DOLICHOPUS CANALICULATUS Thomson.

Dolichopus canaliculatus Thomson, Eugenies Resa, 1868, p. 512.—Osten Sacken, Western Diptera, 1877, p. 315.

Male.—Length, 5 mm.; of wing, 4.5-5 mm. Face narrow, a little wider above, silvery white, a little tinged with yellow above. Front green with more or less violet reflections, dulled with thick yellowish pollen. Antennae yellow; third joint blackish, except at base, about one and a half times as long as wide, pointed at tip. Palpi and proboscis yellow. Lateral and inferior orbital cilia whitish, more yellow above, about four of the upper cilia on each side black.

Thorax green; dorsum often with violet reflections, covered with thick yellowish pollen, the median line and lateral edges a little more shining; pleurae dulled with gray pollen. Abdomen shining green with coppery reflections on the hind margins of the segments; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black; its lamellae (fig. 206a) large, somewhat triangular in outline, with a large and another small emargination on the apical edge, white with the apical corners and narrow upper margin black, lower corner with a branched bristle, upper margin and apical edge as far as the large emargination fringed with black hairs.

Fore coxae yellow with white pollen and minute white hairs on anterior surface; middle and hind coxae black on the outside, yellow on inner side and at tip. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter ciliated with white hairs on lower inner edge for their entire length, the longest being near the tip and about three-fourths as long as width of femora. Middle tibiae with one bristle on lower anterior edge near apical third, their basitarsi without a bristle above. Posterior tibiae a little thickened; the usual glabrous stripe on upper surface distinct, but nearly broken near the tip and widening again at apex of tibia, their inner surface with a glabrous spot near the base which is usually darker yellow than the rest of the tibia. Fore tarsi one and threefourths times as long as their tibiae, first three joints vellow and of nearly equal length; first joint normal, second and third very thin and with their sides glabrous, third sometimes brownish; fourth joint white, a little longer than the width of the tip, somewhat triangular, and with two or three long hairs above; fifth joint much compressed, somewhat orbicular in outline, but straight below, about one-third as long as the third. Middle tarsi about one and a fourth times as long as their tibiae, brownish yellow, becoming darker toward their tips. Hind tarsi black from the tip of the first joint, which is dark yellow. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 206) grayish; costa with a small elongated enlargement at tip of first vein; last section of fourth vein bent just before its middle; third vein bent backward at tip; hind margin of wing indented at tip of fifth vein, nearly evenly rounded, the anal angle being rounded, not at all prominent.

Female.—Agrees with the male in general color of all parts, in having thick pollen on the mesonotum, and in the form of the wings, except that the costa has no enlargement. Face about twice as wide as in the male, third antennal joint shorter; fore tarsi plain, a little longer than their tibiae, first joint about as long as the two following taken together, third a little shorter than second, fourth and fifth of about equal length, and each about half as long as second, first four joints dark yellow, only the fifth black; hind tibiae scarcely thickened and without the glabrous spot on inner surface.

Redescribed from numerous males and females from California. taken in Sonoma, Alameda, Marin, and San Mateo Counties, May to

Type locality.—California, the San Francisco region.

Type.—In Museum of Comparative Zoology, Cambridge, Massachusetts.

No. 207. DOLICHOPUS TENUIPES Althrich.

Dolichopus Aldrich, American Naturalist, 1894, p. 35 (describes courtahip).

Dolichopus tenuipes Aldrich, Kans. Univ. Quart., vol. 2, 1894, p. 155.—MeLANDER and Brues, Biol. Bull., vol. 1, 1900, p. 148.

Male.—Length 5-5.5 mm.; of wing 4-5 mm. Face wide, a little narrowed below, silvery white. Front green, dulled with grayish white pollen. Antennae yellow, third joint blackish with the base yellow, about as long as wide, pointed at tip. Lateral and inferior orbital cilia white, about four of the upper cilia on each side black.

Thorax green with bronze reflections; dorsum covered with thick brownish gray or yellowish pollen; pleurae dulled with white pollen. Abdomen green with more or less bronze reflections; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black; its lamellae rather large, elliptical, but rather pointed at tip, white with a narrow brown border on the apical margin, fringed with little brown hairs on the apical edge and with pale hairs above and below.

Coxae, femora and tibiae yellow; middle and hind coxae more or less blackened on outer surface. Fore coxae with silvery pollen and minute yellow hairs on anterior surface, a few black hairs along the inner edge. Middle and hind femora each with one preapical bristle, the latter without cilia below. Middle tibiae with one bristle below, their basitarsi without a bristle above. Posterior tibiae thickened, their inner surface with a short glabrous spot, which does not reach the base and occupies about one-fourth their length. Fore tarsi (fig. 207a) twice as long as their tibiae: second joint one and a fourth times as long as the first, second and third very thin, glabrous on their sides, brownish, third about equal to the first in length; fourth joint scarcely wider than the third and very short about as long as wide, with two long hairs above; fifth joint very thin. black, compressed, oval, extending far beyond the claws which are placed near its basal third, fringed toward the tip with a few minute black hairs, about two-thirds as long as third joint. Middle tarsi one and one-fourth times as long as their tibiae, brownish almost from the base, but scarcely black even at tip. Hind tarsi blackish from the tip of the first joint, which is dark yellow. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 207) grayish; costa black, without distinct enlargement at tip of first vein, although somewhat thicker at that point and tapering to its tip; last section of fourth vein bent just beyond its basal third; third vein bent backward at its tip; hind margin of wing only a little indented at tip of fifth vein, rather evenly rounded, the anal angle not being prominent.

Female.—Face a little wider than in the male, and more grayish; coxae and wings as in the male; hind tibiae without the glabrous spot

on inner surface and a little less thickened; middle tibiae with three bristles below, two near apical third and one near basal third, their basitarsi without a bristle above; fore tarsi plain, about one and a fourth times as along as their tibiae, brownish, first joint as long as the three following joints taken together, fifth longer than fourth: middle and hind tarsi more black than in the male.

Redescribed from the type material in the collection of J. M. Aldrich, and several males. These were taken at Moscow. Vollmer (now Troy) and Potlatch, Idaho, Aug. 24-Oct. 6; Oakland, California, June 7; Fairfax, Marin County, California, Oct. 15, and Pullman, Washington, Sept.

Type locality.-Moscow, Idaho. Melander and Brues report it from California.

No. 208. DOLICHOPUS DIGITUS, new species.

Male.—Length 4.75 mm.; of wing 4.5 mm. Face wide, its sides parallel, silvery white. Front shining green with bronze reflections. Antennae vellow; third joint somewhat orbicular, still a little pointed at tip, which is a little infuscated. Lateral and inferior orbital cilia vellowish, about four of the upper cilia on each side black.

Thorax green; dorsum with three broad reddish coppery stripes, the lateral ones inclosing a blue spot at the suture (the metallic coloring is likely to vary in different individuals), covered with an almost invisible yellowish pollen, which is more gray and conspicuous along the front; pleurae dulled with white pollen; bristles of the thorax inserted in small black dots. Abdomen green with coppery reflections, especially on the apical segments; the white pollen on its sides abundant. Hypopygium black; its lamellae (fig. 208a) rather large. somewhat triangular, white with a narrow black apical border, jagged and bristly on lower corner, fringed on the rest of the apical margin with little brown hairs.

Coxae, femora, and tibiae yellow; middle coxae with outer surface mostly blackish, anterior surface of fore coxae with silvery pollen and very minute pale hairs and a few black ones on upper half of inner edge. Middle and hind femora each with one preapical bristle, the latter without cilia, but with a row of minute yellow hairs on lower inner edge. Middle tibiae with three bristles below, two near apical third and one near basal third, their basitarsi without a bristle above. Posterior tibiae a little thickened, especially near their base; the usual glabrous stripe on upper surface distinct and reaching the tip; inner surface near the base with a glabrous spot extending one-third the length of the tibiae. Fore tarsi (fig. 208b) nearly twice as long as their tibiae, the first two joints taken together fully as long as the tibia; first joint but little longer than the two following taken together; first three joints and base of fourth yellowish, most of fourth and the whole of fifth black; fifth compressed and with a

finger-like projection on upper edge extending over the claws, this projection is two-thirds as long as the main portion of the joint and a little enlarged at its tip. First two joints of middle and hind tarsi scarcely infuscated at tip (the remaining joints of middle tarsi missing in the type specimen). Calypters and halteres yellow, the former with black cilia with one or two pale hairs among them.

Wings (fig. 208) grayish, very slightly tinged with yellowish brown along the front; costa without an enlargement at tip of first vein; last section of fourth vein bent beyond its basal third; hind margin of wing scarcely indented at tip of fifth vein, nearly evenly rounded, the anal angle being rounded, not prominent.

Described from male taken in Louisiana by Pilate (from the J. M. Aldrich collection).

Tupe.—Male, Cat. No. 23059, U.S.N.M.

No. 209. DOLICHOPUS DUPLICATUS Aldrich.

Dolichopus duplicatus Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 18, pl. 1, fig. 21, and p. 157.

Male.—Length 4.75-6 mm.; of wing 4.5-5.5 mm. Face rather wide, a little narrowed below, yellowish or yellowish white. Front green, the ground color often nearly concealed by yellowish pollen. First two antennal joints yellow; third black, as long as wide, obtusely pointed at tip. Lateral and inferior orbital cilia yellowish, about four of the upper cilia on each side black.

Thorax green; dorsum thickly covered with yellowish pollen, which is thinner on the posterior portion, suture metallic brown with a line of the same color running back over the root of the wings; pleurae dulled with white pollen. Abdomen green with coppery reflections on the posterior margins of the segments; the white pollen on its sides abundant. Hypopygium black; its lamellae (fig. 209a) very large, whitish, sometimes a little tinged with vellow; twice as long as wide, with a deep emargination on the upper edge. which extends a little less than half the width of the lamellae, as wide on the margin as it is deep and somewhat triangular, thus forming two lobes on upper edge, the inner or basal one rather widely bordered with black on outer edge and fringed with delicate but rather long black hairs, outer lobe rather pointed above, narrowly bordered with brown, deeply incised on apical edge, which is fringed with delicate black hairs, there being no branched bristles such as are usually found on the jagged edge of the lamellae; lower edge fringed with short black hairs, which become shorter and pale near the base of the lamella.

Coxae, femora and tibiae yellow. Middle coxae largely blackish on outer surface; anterior surface of fore tarsi with little black hairs and a few minute yellow ones on outer corner near the base. Middle and hind femora each with one preapical bristle, the latter nearly

hare below. Middle tibiae with one large bristle below, their basitarsi with one rather large bristle above near apical third. Posterior tibiae very little thicker than the others; the usual glabrous stripe on upper surface not conspicuous, their inner surface with a narrow glabrous streak at basal third which may be easily overlooked. Fore tarsi (fig. 209b) about one and a half times as long as their tibiae; the first two joints being nearly as long as the tibia; three first joints brownish yellow, last two black; second joint three-fourths as long as first, third two-thirds as long as second, slightly widened at tip; fourth joint one-third as long as third, somewhat triangular, about as wide at tip as it is long; fifth joint much compressed, about as long as third and nearly as wide, somewhat oval; fourth and fifth joints fringed above with little black hairs. Middle tarsi one and a fourth times as long as their tibiae, black from the tip of the second joint, still the second joint is often brownish. Hind tarsi blackened from the tip of the first joint, their basitarsi with two large bristles above. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 209) grayish; costa not enlarged at tip of first vein; last section of fourth vein bent at its middle; hind margin of wing indented at tip of fifth vein, rather evenly rounded, the anal angle being rounded, not prominent.

Female.—Face wider than in the male; antennae, coxae and wings as in the male, except that the wing of the female is more tinged with brown, especially in front of third vein; the middle tibiae have three bristles below, two near apical third and one near basal third, their basitarsi without a bristle above; hind basitarsi with one large bristle above; fore tarsi plain, a little infuscated toward their tips, sometimes quite brownish from their base on upper edge, a little longer than their tibiae, fourth and fifth joints of about equal length.

Redescribed from 11 males and 3 females from the collection of J. M. Aldrich. Two were taken at Keyport, Washington, August 7; 3 at Seattle, Washington; 5 at Moscow, Idaho; 2 at Viola, Idaho; and 2 at Horseshoe Bend, Idaho, June 24. There is a specimen in the United States National Museum taken on the campus at Stanford University, California, September 26, 1909. A. L. Melander took a female at Thompson, Montana, August 25.

Type locality.—Washington.

Type.—In the collection of the University of Kansas.

No. 210. DOLICHOPUS GRANDIS Aldrich.

Dolichopus grandis Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 21, pl. 1, fig. 22.

Male.—Length 6.8-7.8 mm.; of wing 7-7.3 mm. Face rather wide, white, yellowish above. Front shining green with slight bronze reflections. Antennae yellow; third joint a little infuscated at tip,

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scarcely as long as wide, pointed at tip. Lateral and inferior orbital cilia yellowish white, about five of the upper cilia on each side black.

Thorax green with coppery reflections, which form three vittae on the dorsum, the median one narrow and sharply defined, the lateral ones broad; dorsum somewhat dulled with yellowish pollen, which is most conspicuous along the front; pleurae dulled with white pollen. Abdomen green with coppery reflections; the usual white pollen forming large conspicuous spots on the sides of the segments; those on the sides of the fifth segment are sharply defined. large, somewhat oval, and appear to be on a white ground color and without the usual black hairs; those on the other segments are of the usual character but with rather dense pollen. Hypopygium black with green reflections on basal portion; its lamellae (fig. 210a) large. somewhat quadrilateral, the upper and lower edges nearly parallel and the apex truncate with a rather acute point extending from upper corner; they are twice as long as wide, white with rather narrow black border on apical and the outer half of upper margin, jagged and bristly on apical margin, with long delicate vellowish hairs at the extreme point and along the upper edge for a short distance; the rest of upper edge with short black hairs; below they are fringed with a few small pale hairs.

Fore coxae wholly, middle and hind coxae largely yellow, the middle and hind ones blackened on most of their outer surfaces; fore coxae with anterior surface covered with minute yellow hairs, sometimes with a few black ones at base on outer edge; femora and tibiae vellow. Middle and hind femora each with one preapical bristle, the latter ciliated on lower inner edge from before the middle nearly to their tips with yellow hairs, these hairs of somewhat equal length and about three-fourths as long as the width of the femora; they are continued nearly to the base of the femora by very short yellow hairs. Middle tibiae with three bristles below, two near apical third and one near basal third, their basitarsi with one large bristle above near apical third. Posterior tibiae a little thickened; the usual glabrous stripe on upper surface is somewhat broken by a few hairs, but is quite distinct and extends inside of the inner row of large bristles, quite widely so near the base. Fore tarsi (fig. 210b) one and a half times as long as their tibiae; first two joints yellow, second very thin, one-fourth longer than first, glabrous on the sides, with a row of conspicuous, but short, black hairs, of uniform length on both edges; last three joints black, compressed, taken together two-thirds as long as first, third a little longer than fourth and slightly shorter than fifth, a little widened, more so at tip, fourth slightly wider than third, about as wide as long, fifth nearly orbicular in outline, tipped with little white hairs, which are quite conspicuous. Middle and hind tarsi black from the tip of the first joint, the former about one and a fourth times as long as their tibiae. Calypters and halteres vellow, the former with black cilia.

Wings (fig. 210) tinged with yellowish brown; costa a little enlarged at tip of first vein, tapering to its tip; second and third veins considerably arcuated and bent backward at tip; last section of fourth vein bent before its middle; beyond this bend it is a little arched; hind margin of wing notched at tip of fifth vein; anal angle cut off nearly parallel with sixth vein, not rounded, the wing being narrowed at its base.

Female.—Face wide, gravish; hind femora without cilia; fore tarsi plain, one and a fourth times as long as their tibiae, black from the tip of the first joint; fifth joint as long as third, fourth shorter; wings with the veins less arcuated and the anal angle slightly more rounded.

Redescribed from the type which was taken in California; 2 males and 2 females taken at Corvallis, Oregon, July (Aldrich); 2 males taken at Salem, Oregon, July 4; and 1 female taken at Fieldbrook, California, May 31.

The male and female both sometimes have a second bristle on upper edge of middle basitarsi before the middle, which is smaller than the one near basal third.

Types.—University of Kansas and in Aldrich collection.

No. 211. DOLICHOPUS SUPERBUS, new species.

Male.—Length 5.5-7 mm.; of wing 6-7 mm. General color, pollen of thorax, face and front, bristles of middle tibiae and basitarsi, and form of wing, the same as in grandis Aldrich, except that the bend on the last section of fourth vein is at or very near basal third and the anal angle of wing is slightly more rounded (fig. 211). The hypopygial lamellae (fig. 211b) are long and narrow, being four times as long as wide; they taper abruptly and nearly evenly at tip into a rather long and acute point; are white with a moderately wide black border around the apical end; there are one or two branched bristles below the point at tip; this point is black and fringed with long, delicate yellowish hairs, both above and below as well as at tip; some of these hairs may have a brownish color, upper edge fringed with black hairs and lower edge with little pale hairs. Middle and hind femora each with one preapical bristle, the latter with a few vellowish hairs on lower inner edge near apical third, the longest being nearly half as long as width of femora; they become shorter rapidly both toward base and tip, although continued the whole length of the femora by minute yellow hairs; there are scarcely enough of these hairs to call them cilia. Hind tibiae as in grandis. Fore tarsi (fig. 211a) one and two-thirds times as long as their tibiae; first three joints vellow, still the third is sometimes almost black, second and third very thin, glabrous on the sides, second fringed on edges with

black hairs as in grandis; third joint a little wider than the second, nearly twice as long as fourth, and fully as long as fifth, which is a little longer than in grandis; fifth joint oval with a few white hairs at tip, but they are not conspicuous as in grandis; fourth and fifth joints black, the fourth longer than wide.

Female.—Is almost like that of grandis; still the third vein is a little straighter and therefore more parallel with fourth; the bend in fourth vein is a very little nearer the cross vein, and perhaps the face is a little more white in color than that of grandis.

Described from 3 males and 2 females taken in Monterey County, California, July 12.

Type.-Male, Cat. No. 23060, U.S.N.M.

No. 212. DOLICHOPUS RUFICORNIS Loew.

Dolichopus ruficornis Loew, Neue Beitr., vol. 8, 1861, p. 21; Mon. N. Amer. Dipt., pt. 2, 1864, p. 63.

Male.—Length 4.3-5 mm.; of wing 4-4.5 mm. Face of moderate width, a little wider above, silvery white. Front shining green, usually with blue or violet reflections. Antennae (fig. 212a) yellow; third joint about one and one-half times as long as wide, nearly straight above, rounded below, pointed at tip. Lateral and inferior orbital cilia white, about four of the upper cilia on each side black.

Thorax green with slight bronze, and usually with conspicuous blue reflections; dorsum dulled with a little grayish pollen; pleurae with white pollen. Abdomen green with bronze reflections; the white pollen on its sides abundant. Hypopygium black, more or less yellowish on upper side; its lamellae of moderate size, somewhat orbicular, white with a narrow black border on the apical margin, jagged and bristly at lower corner, fringed above with little black hairs.

Coxae, femora, and tibiae yellow, almost whitish; middle coxae with a blackish streak on outer surface; fore coxae with white pollen and very minute white hairs on the anterior side, these hairs so small that the surface appears almost glabrous. Middle and hind femora each with one preapical bristle, the latter with very minute white hairs on the lower half, and ciliated on lower inner edge with long, delicate white hairs, the longest of which are slightly longer than the width of the femora. Middle tibiae with one bristle on lower anterior edge near basal third, their basitarsi without a bristle above. Posterior tibiae only slightly thickened; the usual glabrous stripe on upper surface narrow and reaching from near the base to apical third; there is also a glabrous streak on inner surface from the base to near their middle. Fore tarsi (fig. 212b) nearly one and three-fourths times as long as their tibiae; first four joints pale yellow, fifth black, compressed, nearly orbicular, still a little wider at tip; second joint three-

fifths as long as first, third three-fourths as long as second, fourth about one-fourth as long as third, and about equal to fifth in length, very slightly widened at tip; middle and hind tarsi more than one and one-fourth times as long as their tibiae, darkened toward their tips, but not black; posterior basitarsi with two large bristles above. Calypters and halteres pale yellow, the former with black cilia.

Wings (fig. 212) grayish, usually with a yellowish tinge which is more conspicuous along the front of the wing; veins yellowish brown; costa yellow on inner edge with a small knot-like enlargement at tip of fourth vein; last section of fourth vein bent before its middle; hind margin of wing a little indented at tip of fifth vein, nearly evenly rounded, the anal angle being obsolete.

Female.—Face wider than in the male, silvery white; hind femora without cilia, but with minute white hairs on lower half; fore tarsi plain, about one and one-third times as long as their tibiae; all tarsi only a little darkened toward their tips; costa without an enlargement at tip of fifth vein; anal angle of wing more prominent than in the male, still it is rounded off.

Redescribed from the type material and 6 males and 1 female. Two males and the female were taken at Fayetteville, Arkansas, July 30-August 15; 1 male at Lawrence, Kansas; 2 males in Eric County, New York (1 at East Aurora, July 12; 1 on Grand Island, August 18); and 1 male at Niagara Falls, New York, July 20.

Type locality-Middle States.

Type.—Museum of Comparative Zoology, Cambridge, Massachusetts.

No. 213. DOLICHOPUS LONGIPENNIS Loew.

Dolichopus longipennis Loew, Neue Beitr., vol. 8, 1861, p. 13; Mon. N. Amer. Dipt., pt. 2, 1864, p. 57.—Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 13, pl. 1, fig. 8.—Melander and Brues, Biol. Bull., vol. 1, 1900, p. 148.—Johnson, Bull. Amer. Mus. Nat. Hist., vol. 32, 1913, p. 64.

Male.—Length, 5-6 mm.; of wing, 6-7 mm. Face rather wide, a little narrowed below, silvery white, more or less tinged with yellow above. Front green, sometimes with blue reflections, shining but with thick gray pollen along the orbits. Antennae yellow; third joint more or less blackened at tip, a little longer than wide, obtusely pointed. Lateral and inferior orbital citia pale yellow, about eight of the upper cilia on each side black.

Thorax green, usually with a narrow median and wide lateral stripes of a bronze or coppery color on the dorsum; pleurae dulled with white pollen. Abdomen green with coppery reflections; the white pollen on its sides abundant and reaching upon the dorsum. Hypopygium black; its lamellae of moderate size, somewhat elliptical, nearly twice as long as wide, white with a wide black border on

apical margin, which extends narrowly along the upper edge; jagged and bristly at apex, fringed above with a few bristle-like hairs.

Coxae, femora, and tibiae vellow. Middle coxae more or less blackened on outer surface; anterior surface of fore coxae covered with white pollen and delicate yellow hairs, sometimes with a few minute black hairs along the inner edge. Middle and hind femora each with one prespical bristle, the latter without cilia, but with a row of minute yellow hairs on lower inner edge. Middle tibiae with three bristles below, two near apical and one near basal third, their basitarsi with a large bristle near apical third. Posterior tibiae a little thickened; the usual glabrous stripe on upper surface distinct, but a little broken by a few hairs; just inside of the inner row of large bristles is another narrow glabrous stripe extending their whole length and uniting with the upper one at the tip of the tibiae. Fore tarsi (fig. 213a) one and a fourth times as long as their tibiae. yellow with the last two and a half joints black; first two joints plain, second joint fully three-fourths as long as first; last three joints scarcely at all compressed, taken together about as long as second; third and fourth joints fringed above with long black hairs, fifth somewhat orbicular and fringed above with little black hairs. Middle tarsi blackened from the tip of the first joint, still the second often vellow-Hind tarsi deep black from the tip of the first joint. Calvpters and halteres vellow, the former with black cilia.

Wings (fig. 213) long, narrowed toward the root, grayish, more or less tinged with yellowish brown; costs with a small knot-like enlargement at tip of first vein; last section of fourth vein bent beyond its basal third, the posterior angle of this bend often bears a stump; hind margin of wing a little indented at tip of fifth vein; there is a slight lobe at tip of sixth vein and another at the anal angle, with a shallow sinus between them.

Female.—Very like the male, except the face is wider, and there is only a slight indication of the lobe at tip of sixth vein, the hind margin being more broadly rounded and the anal angle slightly cut off from the tip of the sixth vein.

Redescribed from many males and females from the following locations: Lafayette, Indiana, May 19-July 4; Merchantville, New Jersey, (Johnson), June 28; Plummers Island, Maryland, July 28; Chain Bridge, District of Columbia, June 15; East Falls Church, Virginia, (Banks), August 3; Irving, New York, August 26; Ithaca, New York; Montgomery County, Pennsylvania, July 4; Ohio; Columbia, Missouri, June 1; Knoxville, Tennessee, May 21 (Summers); North Carolina; Florida; Lawrence, Kansas, July; Waubamic, Ontario, June 14 (Parish).

Type localities.—Middle States and Washington, District of Columbia. Melander and Brues report it from Vancouver Island; Johnson from Florida.

No. 214. DOLICHOPUS SAROTES Locw.

Dolichopus sarotes LOEW, Cent., vol. 7, 1866, No. 81.—Melander and Brues, Biol. Bull., vol. 1, 1900, p. 148.—ALDRICH, Cat. N. Amer. Dipt., 1905, p. 304, note.

Male.—Length 5-5.5 mm.; of wing 5-5.7 mm. Face wide, only a little narrowed below, silvery white. Front green, sometimes with blue or violet reflections. Antennae yellow; third joint about as long as wide, obtusely pointed at tip, sometimes infuscated on apical half. Lateral and inferior orbital cilia vellowish, about eight of the upper cilia on each side black.

Thorax green, usually with bronze reflections; dorsum usually with three coppery vittae, the median one narrow and sharply defined, dulled with a little grayish pollen, especially along the front; pleurae dulled with white pollen. Abdomen green with coppery reflections; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black with metallic reflections on basal portion; its lamellae of moderate size, somewhat elliptical, nearly twice as long as wide, yellowish or whitish with a black border, which is wide on apical, narrow on upper margin, jagged and bristly at apex, fringed on upper edge with rather long black hairs, below with a few small pale hairs.

Coxae, femora and tibiae yellow. Middle coxae blackened on outer side; fore coxae with white pollen and little pale hairs on their anterior surface, mixed with the pale hairs on apical third are a few minute black ones, which also cover the inner edge to their base. Middle and hind femora each with one preapical bristle, the latter nearly bare below, still with a row of little yellow hairs on lower inner edge. Middle tibiae with three bristles below, two at apical and one at basal third, their basitarsi with one large bristle above near apical third. Posterior tibiae a little thickened, the usual glabrous stripe on upper surface distinct but broken; inner surface with a glabrous spot near basal third, where the tibiae are slightly more thickened, from the spot extending to the tip is a glabrous line, formed by the omission of a single row of little hairs. Fore tarsi (fig. 214) one and a fourth times as long as their tibiae, yellow, black from the middle of the third joint; second joint scarcely two thirds as long as first, last three joints taken together scarcely as long as the second, black; third and fourth fringed above with long black hairs, slightly compressed, fourth about as wide as long, fifth joint nearly orbicular, fringed above with little black hairs. Middle and hind tarsi black from the tip of the first joint, the former a little longer than their tibiae. Calvpters and halteres yellow, the former with black cilia.

Wings (figs. 214a) gravish; inner edge of costa yellowish; costa with a slight elongated enlargement at tip of first vein; last section of fourth vein bent just beyond its basal third, sometimes the posterior

angle of this bend bears a stump; hind margin of wing distinctly indented at tip of fifth vein; anal angle very prominent.

Female.—Face wide, white; fore tarsi plain, first joint slightly longer than the two following taken together, second more than half as long as first and about as long as third and fourth taken together, fifth scarcely as long as fourth, last three joints black, still the base of third more or less yellow; wing as in the male, except that the anal angle is not quite so prominent.

Redescribed from five males and two females, the males were taken as follows: One at Delaware Water Gap, New Jersey, July 11; two at Lafayette, Indiana, July 4; one at Toronto, Ontario, June 13; and one at Fort Erie, Ontario, July 4.

Type locality.—Illinois. Melander and Brues report it from Wisconsin.

Aldrich in a note in the Catalogue of North American Diptera gives the color and size of the third joint of fore tarsi as a distinguishing character of this and longipennis. I do not find these characters reliable, at least they are not very certain, but the two species are readily separated by the form of the anal angle of the wing, in sarotes the anal angle is very prominent and evenly rounded, the wing being of nearly equal width, while in longipennis it is rather prominent but much narrowed and there are two small lobes one at tip of sixth vein and one at the anal angle; they are also separated by the second joint of fore tarsi being nearly as long as the first in longipennis and scarcely two-thirds as long as first in sarotes.

No. 215, DOLICHOPUS CUPRINUS Wiedemann.

Dolichopus cuprinus Wiedemann, Auss. Zw., vol. 2, 1830, p. 230.—Say, Journ. Acad. Sci. Phila., vol. 3, 1823, p. 86, complete works, vol. 2, p. 76 (both cupreus, preoccupied).—Loew, Neue Beitr., vol. 8, 1861, p. 20; Mon. N. Amer. Dipt., pt. 2, 1869, p. 55.—Aldrich, Kansas Univ. Quart., vol. 2, 1893, p. 12, pl. 1, fig. 7.—Melander and Brues, Biol. Bull., vol. 1, 1900, p. 148.—Johnson, Insects of New Jersey, 1909, p. 756.

Male.—Length 4-6 mm.; of wing 4-5.3 mm. Face wide, only a little narrowed below, silvery white, slightly tinged with yellow above. Front green, sometimes blue, or even dark violet, shining. Antennae yellow; third joint a little longer than wide, pointed at tip, which is sometimes a little infuscated. Lateral and inferior orbital cilia yellowish white, with five or six stout black cilia on each side above.

Thorax green with bronze and usually blue reflections, and with three coppery vittae on the dorsum, the median one narrow and sharply defined (in one specimen before me the dorsum is deep violet and the vittae are dark green); dorsum a little dulled with grayish pollen; pleurae with whitish pollen. Abdomen green with bronze and coppery reflections; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black; its lamellae of moderate

size, somewhat elliptical, white or yellowish white with a black border, which is broad on lower apical corner, jagged and bristly at apex, fringed above with a few black hairs.

Coxae, femora, and tibiae yellow. Middle coxae blackened on outer surface: fore coxae with white pollen and delicate little white hairs on anterior surface, and with a few small black hairs at base on inner edge, which sometimes extend narrowly to the tip. Middle and hind femora each with one preapical bristle, the latter ciliated on lower inner edge with long yellow hairs, the longest of which are longer than the width of the femora, these long hairs begin near the middle of the femora and do not reach the tip, on the basal half of the femora the hairs become much shorter and are very short toward the base. Middle tibae with three bristles below, two near apical and one near basal third, their basitarsi with one large bristle above near apical third. Posterior tibiae but little thickened; the usual glabrous stripe on upper surface distinct but not quite reaching the base; inner surface largely glabrous; on apical fourth it is narrowed to a line inside of the inner row of large bristles. Fore tarsi (fig. 215) nearly one and a half times as long as their tibiae, first two joints taken together nearly as long as the tibia, slender, yellow, second joint two-thirds as long as the first; last three joints taken together as long as the second, third with its basal half or more whitish, apex black, scarcely widened, fringed on upper edge with long, dense, black hairs; fourth and fifth joints taken together scarcely as long as third, fourth slightly longer than fifth and a little wider, fringed above with black hairs which are not as long as those on the third joint. Middle and hind tarsi black from the tip of the first joint, the former about one and a fourth times as long as their tibiae. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 215a) grayish, slightly tinged with brown in front; costa with a very slight enlargement at tip of first vein; last section of fourth vein bent at right angles before its middle and with a stump at the posterior bend; anterior bend usually rounded, very rarely with a sharp right angle and a stump; third vein bent backward a very little toward the tip but usually running parallel with the fourth at tip; hind margin of wing slightly indented at tip of fifth vein, evenly rounded, the anal angle being rounded and not very prominent.

Female.—Face wider than in the male and more grayish, hind femora without cilia; fore tarsi plain, a little longer than their tibiae, the first joint about as long as the three following taken together, fourth very slightly longer than fifth; hind tibae without the glabrous surface on inside.

Redescribed from numerous specimens from the following places: Portland, Maine, July 9; Evanston, Illinois, July; Hancock, Maryland, May 29; Milbank, South Dakota; Lafayette, Indiana, June 11; Hartford, Connecticut, June 15; New Jersey, July 14; Western New York, June 14-September 6; Fort Erie, Ontario, June 20; Toronto, Ontario, July 4-12: Kearney, Ontario, July 27; Montreal, Quebec, July 21.

Type locality.—Maryland. Loew reports it from Virginia and Nebraska; Aldrich from Massachusetts and Kansas; Melander and Brues from Illinois, Wisconsin, Wyoming; Johnson from Jamesburg, New Jersey, July 4, Dover, New Jersey, June 16, Merchantville, New Jersey, June 28.

No. 216. DOLICHOPUS ABSONUS, new species.

Male.—Length 5-6 mm.; of wing 5.5-6 mm. Face wide, silvery white, tinged with yellow above, a little narrowed below. Front shining green, sometimes with blue reflections. Antennae yellow; third joint a little longer than wide, obtusely pointed at tip, which is sometimes a little infuscated. Lateral and inferior orbital cilia yellowish white, about six of the upper cilia on each side black.

Thorax green or blue-green, with coppery reflections, which usually form three vittae on the dorsum, the median one narrow and sharply defined; dorsum a little dulled with gray pollen; pleurae with white pollen. Abdomen green with coppery reflections; the white pollen on its sides abundant and extending upon the dorsum. Hypopygium black; its lamellae of moderate size, somewhat elliptical in outline, about twice as long as wide, whitish with a black apical border, which is widest at upper corner, jagged and bristly at apex, fringed above with a few black hairs.

Coxae, femora and tibiae yellow. Middle coxae blackened a little on outer surface; fore coxae with white pollen and delicate little whitish hairs on anterior surface, sometimes with numerous little black hairs along inner edge. Middle and hind femora each with one preapical bristle, the hind ciliated with long vellowish white hairs on lower inner edge for nearly their whole length; these hairs are of nearly equal length, and not over one-half as long as the width of the femora, sometimes much shorter than that, so they could scarcely be called cilia. Middle tibiae with three bristles below, two near apical and one at basal third, their basitarsi with one bristle near apical third. Posterior tibiae only slightly thickened, the usual glabrous stripe on upper surface distinct but narrow, the inner surface largely glabrous, still the glabrous portion narrowing toward their tips and reduced to a narrow line on apical fourth. Fore tarsi (fig. 216) about one and a third times as long as their tibiae, the first two joints taken together being as long as the tibia, second two-thirds as long as first, both yellow; third joint with its basal half white. apical half black, a little less than half as long as second, compressed. fringed above with long dense black hairs which begin before the middle of the joint, usually preceded by a single long hair nearer the

base; fourth and fifth joints deep black, of nearly equal length, fourth about as wide as long, fringed above with black hairs which are shorter than those on third joint, fifth narrower than fourth, oval, fourth and fifth taken together about equal to third in length. Middle and hind tarsi about one and a half times as long as their tibiae, black from the tip of the first joint. Calypters and halteres vellow, the former with black cilia.

Wings (fig. 216a) grayish, slightly tinged with brown in front; costa with a small elongate enlargement at tip of first vein; last section of fourth vein bent at a right angle before its middle, the posterior bend with a stump, the anterior bend usually rounded, but sometimes it is also a right angle, rarely there is no stump at either bend; third vein bent backward at tip a very little; hind margin of wing a little indented at tip of fifth vein; anal angle prominent, extending a very little toward the root of the wing.

Female.—Face wide; fore tarsi plain, black from the middle of the third joint; wing about as in the male, hind femora without cilia.

Described from many males and females: Grand Island, Erie County, New York, August 7-29; Buffalo, New York, September 2 (Van Duzee); Battle Creek, Michigan (Aldrich); Fort Erie, Ontario, July 2; Ridgeway, Ontario, July 6-September 6; Montreal, Quebec, August 17.

This differs from cuprinus Loew in the shorter cilia of the hind femora, and the more compressed and larger third joint of fore tarsi, which is also fringed with longer and denser hairs, the anal angle of the wing is much more prominent in absonus than in cuprinus.

Type.-Male, Cat. No. 23061, U.S.N.M.

No. 217, DOLICHOPUS MICROPYGA Wahlberg.

Dolichopus micropyge WARLBERG, Vet. Akad. Förhandl., 1850, p. 216.—Zetter-STEDT, Dipt. Scand., vol. 11, 1852, p. 4278.

Two females that may be this species were taken in Colorado by Baker. They are a little longer than the description would call for and the tibiae seem to be a little different color, the four anterior ones being wholly yellowish and the posterior ones almost wholly black, as I understand Zetterstedt the tibiae should all be testaceous or yellowish with black tips, still in most points they agree with his description.

They have the face wide, whitish; front shining green; lateral and inferior orbital cilia whitish yellow, about eight of the upper cilia on each side black. Thorax and abdomen green, the former dulled with brownish pollen. Coxae black, anterior pair with black hairs on the front side; anterior femora black with yellow tips; middle femora vellowish with the lower edge black for two-thirds their length: hind femora yellowish with upper and lower edges black; fore and middle tibiae wholly yellowish, the former with one bristle below, their bastarsi without a bristle above. Middle and hind femora each

with one preapical bristle; hind tibiae black, a very little yellowish above at base; fore tarsi yellowish, a little infuscated from the tip of the first joint; middle and hind tarsi black, the former with the first joint a little tinged with yellow. Calypters and halteres yellow, the former with black cilia.

Wings dark grayish; last section of fourth vein bent just before its middle; hind margin of wing not indented at tip of fifth vein; anal angle prominent.

Type.—In University of Lund, Sweden, from Europe.

No. 218. DOLICHOPUS AETHIOPS, new species.

Female.—Length, 5.2 mm.; of wing, 5.7 mm. Face wide, yellowish brown, the black ground color showing through its pollen. Front and occiput opaque, with yellowish brown pollen. Antennae wholly black, still the first joint appears gray on the lower edge when viewed from below; lateral and inferior orbital cilia yellowish, almost the color of the pollen of the face, about eight of the upper cilia on each side black.

Dorsum of the thorax greenish, but so thickly covered with yellowish brown pollen as almost to conceal the ground color; pleurae more blackish with gray pollen. Abdomen greenish with coppery reflections and wide black incisures, rather thickly covered with grayish white pollen.

Coxae, femora, tibiae and tarsi black, with the articulations of the femora and tibiae yellowish; middle tibiae with one large bristle below, their basitarsi without a bristle above; posterior basitarsi with two large bristles above. Calypters and halteres yellow, the former with black cilia.

Wings dark grayish or brownish, the veins narrowly bordered with brown; last section of fourth vein a little bent before its middle; hind margin of wing not indented at tip of fifth vein, rather evenly rounded; wings wide, widest just before the tip of fifth vein; anal angle prominent.

Described from 1 female taken by J. M. Aldrich at Lafayette, Indiana, March 28.

Type.—Female, Cat. No. 23062, U.S.N.M.

I am describing this rather remarkable form from the female, as it seems to me that the male will very easily be recognized when found.

No. 219. DOLICHOPUS, species.

A female taken in Alaska which has the cilia of the calypters yellow, antennae mostly yellow, and the middle tarsi wholly deep black. It does not seem best to give this a name without more specimens, in fact not until the male is found; still it seems to be an entirely new form and quite interesting, therefore I have run it into the table of species and mentioned it here. Professor Hine took it in Alaska.

PLATES.

By F. R. COLE.

EXPLANATION OF PLATES.

The numbers correspond in all cases except No. 217 to the number assigned to the species in the text. There are six species for which we have no drawing, Nos. 13, 76, 81, 118, 139, 143. What should have been number 130 has been placed at the end of the drawings as No. 217, it being made after most of the plates were made up.

PLATE 1.

Figs. 1-17a: 1, calainus Melander and Brues, hypopygial lamella; 2, monticola, new species, wing of male; 2a, same, antenna of male; 3, barbaricus, new species, wing of male; 3a, same, antennae of male; 4, sordidatus, new species, wing of male; 4a, same, hypopygial lamella; 5, formosus, new species, wing of male; 5a, same, hypopygial lamella; 6, squamosus, new species, wing of male; 6a, same, middle tibia and tarsus; 7, viridis, new species, wing of male; 7a, same, antenna; 8, nigrimanus, new species, wing of male; 8a, same, hypopygial lamella; 9, nigricauda, new species, wing of male; 9a, same, hypopygial lamella; 10, ovatus Loew, hypopygial lamella; 10a, same, antenna of male; 11, myosota, Osten Sacken, wing of male; 11a, same, hypopygial lamella; 12, multisetosus, new species, wing of male; 12a, same, hypopygial lamella; 14, detersus, Loew, wing of male; 14a, same, hypopygial lamella; 15, enigma Melander and Brues, wing of male; 15a, same, hypopygial lamella; 15b, same, antenna of male; 16, adaequatus, new species, wing of male; 16a, same, hypopygial lamella; 16b. same, antenna of male; 17, paluster Melander and Brues, wing of male; 17a, same, antenna of male.

PLATE 2.

Figs. 18-32a: 18, tetricus Loew, fore tarsus of male; 19, manicula, new species, wing of male; 19a, same, fore tarsus of male; 20, corax Osten Sacken, fore tarsus of male (inverted); 21, acricola, new species, wing of male; 21a, same, fore tarsus of male; 22, stenhammari Zetterstedt, wing of male; 22a, same, hypopygial lamella; 23. argentipes, new species, wing of male; 24, acuminatus Loew, hypopygial lamella; 24a, same, antenna of male; 25, beatus, new species, hypopygium of male; 26, demissus, new species, wing of male; 26a, same, antenna of male; 26a, burnsii, new species, hypopygial lamella; 26a, same, fore tarsus of male (inverted); 27, conspectus, new species, wing of male; 27a, same, hypopygial lamella; 28, agronomus Melander and Brues, wing of male; 28a, same, antenna of male; 29. gratus Loew, wing of male; 29a, same, antenna of male; 30, calcaratus Aldrich, wing of male; 31a, same, hypopygial lamella; 31, melanderi, new species, wing of male; 31a, same, hypopygial lamella; 32, johnsoni Aldrich, wing of male; 32a, same, antenna of male.

PLATE 3.

Figs. 33-48a: 33, appendiculatus, new species, wing of male; 33a, same, middle tibia of male; 33b, same, middle tarsus of male (inverted); 34, fumosus, new species, wing of male; 34a, same, antenna of male; 35, convergens Aldrich, wing of male;

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35a, same, antenna of male; 36, nubifer, new species, wing of male; 37, barbicauda, new species, hypopygial lamella; 37a, same, antenna of male; 38, bisetosus, new species, hypopygial lamella; 38a, same, antenna of male; 39, intentus Melander and Brues, hypopygial lamella (copied); 40, angusticornis, new species, antenna of male; 40a, same, hypopygial lamella; 41, aequalis, new species, wing of male; 41a, same, hypopygial lamella; 41b, same, fore tarsus of male; 42, litoralis, new species, hypopygial lamella; 42a, same, wing of male; 43, packardi, new species, wing of male; 44, xanthocnemus Loew, wing of male; 44a, same, antenna of male; 45, albiciliatus Loew, wing of male; 45a, same, hypopygial lamella; 46, alacer, new species, wing of male; 46a, same, hypopygial lamella; 47, partitus Melander and Brues, wing of male; 47a, same, antenna of male; 48, setifer Loew, wing of male; 48a, same, antenna of male.

PLATE 4.

Figs. 49-60: 49, retinens, new species, anterior tibia and tarsus; 49a, same, wing of male; 50, remipes Wahlberg, wing of male; 50a, same, posterior tarsus of male (inverted); 51, sedulus, new species, wing of male; 51a, same, hypopygial lamella; 52, groenlandicus Zetterstedt, wing of male; 52a, same, hypopygial lamella; 54, remus, new species, wing of male; 54a, same, hypopygial lamella; 54b, same, middle tibia of male; 54c, same, middle tarsus of male (inverted); 55, adultus, new species, wing of male; 55a, same, hypopygial lamella; 55b, same, antenna of male; 56, fusiformis, new species, wing of male; 56a, same, hypopygial lamella; 57, umbrosus, new species, wing of male; 57a, same, hypopygial mof male; 58, laticornis Loew, wing of male; 58a, same, antenna of male; 59, nodipennis, new species, wing of male; 59a, same, antenna of male; 59, nodipennis, new species, wing of male; 59a, same, antenna of male; 60, solidus, new species, wing of male.

PLATE 5.

Figs 61-77: 61, bryanti, new species, wing of male; 62, amnicola Melander and Brues, wing of male; 62a, same, antenna of male; 63b, same, new species, wing of male; 63a, same, hypopygial lamella; 63b, same, antenna of male; 64, humilis, new species, wing of male; 64a, same, antenna of male; 65, brevicauda, new species, wing of male; 65a, same, hypopygial lamella; 65b, same, antenna of male; 66, varipes Coquillett, wing of male; 66a, same, fore tarsus of male; 67, flavilacertus, new species, wing of male; 67a, same, antenna of male; 68, rupestris Haliday, wing of male; 69, fucatus, new species, wing of male; 69a, same, hypopygial lamella; 70, apheles Melander and Brues, wing of male; 70a, same, hypopygial lamella; 72, discolor, new species, wing of male; 71a, same, hypopygial lamella; 72, discolor, new species, wing of male; 72a, same, hypopygial lamella; 73, sincerus, Melander, wing of male; 74, sincerus, var. subdirectus, new variety, wing of male; 75, genualis, new species, wing of male; 75a, same, hypopygial lamella; 77, obsoletus, new species, wing of male.

PLATE 6.

Figs. 78-91: 78, trisetosus, new species, wing of male; 78a, same, antenna of male; 79, comatus Loew, middle tibia and basitarsus of male; 79a, same, wing of male; 80, virga Coquillett, wing of male; 80a, same, fore tarsus of male, from above; 82, pachycnemus Loew, antenna of male; 82a, same, hypopygial lamella; 82b, same, hind femora of male; 82c, same, fore tarsus of male; 83, ungulatus Linnaeus, wing of male; 83a, same, hypopygial lamella; 84, barbipes, new species, anterior tibia and tarsus of male (inverted); 85, brevipennis Meigen, wing of male; 85a, same, fore tarsus of male (inverted); 86, dasyops Malloch, hypopygial lamella (copied); 87, ornatipennis, new species, wing of male; 87a, same, hypopygial lamella; 88, dorycerus Loew, wing of male; 88a, same, antennae of male; 88b.

same, fore tarsus of male; 89, socius Loew, wing of male; 90, socius, var. gladius, new variety, wing of male; 91, brevimanus Loew, wing of male.

PLATE 7.

Figs. 92-107: 92, indigena, new species, wing of male; 92a, same, fore tarsus of male; 93, idoneus, new species, wing of male; 98a, same, hypopygial lamella; 94, canadensis, new species, antenna of male; 94a, same, fore tarsus; 95, acutus, new species, wing of male; 95a, same, antenna of male; 96, defectus, new species, wing of male; 96a, same, antenna of male; 97, abbreviatus, new species, lamella of hypopygium; 98, cuniculus, new species, hypopygium of male; 98a, same, wing of male; 98b, same, antenna of male; 99, brunneus Aldrich, wing of female; 100, ramifer Loew, wing of male; 100a, same, hypopygial lamella; 101, incisuralis Loew, wing of male; 102, melanocerus Loew, wing of male; 102a, same, hypopygial lamella; 103, pantominus Melander and Brues, wing of male; 103a, same, hypopygial lamella; 104, flaviciliatus, new species, wing of male; 104a, same, antenna of male; 104b, same, hypopygial lamella; 105, decorus, new species, wing of male; 106, setosus Loew, wing of male; 106s, same, hypopygial lamella; 107, sarratus, new species, wing of male.

PLATE 8.

Figs. 108-123b: 108, renidescens Melander and Brues, wing of male; 108a, same, hypopygial lamella; 109, hastatus Loew, wing of male; 109a, same, antenna of male; 110, comptus, new species, wing of male; 110a, same, antenna of male; 111, dorsalis, new species, wing of male; 112, abrasus, new species, hypopygial lamella; 113, marginatus Aldrich, hypopygial lamella; 114, reflectus Aldrich, wing of male; 115, albicoxa Aldrich, wing of male; 115a, same, fore tarsus of male; 116, pilatus, new species, antenna of male; 116a, same, fore tarsus of male; 117, porphyrops, new species, wing of male; 117a, same, antenna of male; 117b, same, hypopygial lamella; 117c, same, antenna of female; 119, plumitarisis Fallen, last four joints of fore tarsus (inverted); 120, pollex Osten Sacken, wing of male; 120a, same, fore tarsus of male; 121, obcordatus Aldrich, hypopygial lamella; 121a, same, fore tarsus of male; 122, pernix Melander and Brues, wing of male; 122a, same, hypopygial lamella; 122b, same, fore tarsus of male from above; 123, blandus, new species, wing of male (number omitted on plate, it is just below fig. 121a; 123a, same, hypopygial lamella; 123b same, fore tarsus of male.

PLATE 9.

Figs. 124-136a: 124, vigilans Aldrich, wing of male; 124a, same, fore tarsus of male; 125, flagellitenens Wheeler, wing of male; 125a, same, hypopygial lamella; 125b, same, fore tarsi of male; 126, bifractus Loew, wing of male; 126a, same, fore tarsus of male; 127, pugil Loew, wing of male; 127a, same, fore tibia of male; 127b, same, fore tarsus of male; 128, plumipes Scopoli, wing of male; 128a, same, middle tibia and tarsus of male from above; 129, dasypodus Coquillett, wing of male; 131, flavipes Loew, wing of male; 131a, same, antenna of male; 131b, same, wing of female; 132, flavicoza, new species, wing of female; 132a, eame, hypopygial lamella; 133, variabilis Loew, antenna of male; 133a, same, hypopygial lamella; 134, variabilis, var. gracilis Aldrich, wing; 135, luteipennis Loew, wing of male; 136, greenei, new species, wing of male; 136a, same, hypopygial lamella.

PLATE 10.

Figs. 137-149a: 137, wheeleri Melander and Brues, wing of male; 137a, same, wing of female; 137b, same, middle tarsus of male from above; 138, longimanus Loew, wing of male; 138a, same, last four joints of fore tarsus of male; 138b, same, hypopygial lamella; 140, amplipennis, new species, wing of male; 140a, same, fore tarsus of male (inverted); 140b, same, hypopygial lamella; 141, splendidus Loew, wing of male; 141a, same, hypopygial lamella; 141b, same, last four joints of fore tarsus of male; 142, splendidulus Loew, wing of male; 142a, same, last four joints of fore tarsus of male; 142b, same, hypopygial lamella; 144, discifer Stannius, wing of male; 144a, same, tip of fore tarsus of male; 145, boreus, new species, antenna of male; 145a, same, fore tarsus of male (inverted); 146, angustatus Aldrich, wing of male; 146a, same, last four joints of fore tarsus of male; 147, compactus, new species, wing of male; 147a, same, fore tarsus of male; 148, walkeri, new species, wing of male; 148a, same, fore tarsus of male; 149, speciosus, new species, wing of male; 149a, same, fore tarsus of male (inverted).

PLATE 11.

Figs. 150-161: 150, procerus, new species, wing of male; 150a, same, fore tarsus of male; 151, completus, new species, wing of male; 151a, same, fore tarsus of male; 152, xratus, new species, wing of male; 152a, same, fore tarsus of male; 153, sufflavus, new species, wing of male; 153a, same, fore tarsus of male; 154, coloradensis Aldrich, fore tarsus of male; 155, lobatus Loew, wing of male; 155a, same, fore tarsus of male (the a is omitted after the numeral); 155b, same, wing of female; 156, omnivagus, new species, last two and a half joints of fore tarsus (inverted); 157, amphericus Melander and Brues, fore tarsus of male (inverted); 158, afflictus Osten Sacken, wing of male; 158a, same, hypopygial lamella; 159, crenatus Osten Sacken, wing of male; 159a, same, antenna of male (inverted); 160, consanguineus Wheeler, wing of male; 160a, same, wing of female; 161, brues' (propinquus), new name, wing of male.

PLATE 12.

Figs. 162-175b: 162, aurifex, new species, wing of male; 162a, same, hypopygial lamella; 163, idahoensis Aldrich, wing of male; 164, cavatus, new species, wing of male; 164a, same, hypopygial lamella; 165, penicillatus, new name, wing of male; 166, misellus Melander, hypopygial lamella (copied); 167, chrysostoma Loew, antenna of male; 168, parvicornis, new species, wing of male; 169a, same, hypopygial lamella; 170, harbecki, new species, wing of male; 170a, same, wing of female; 170b, same, antenna of male; 171, slossonae, new species, wing of male; 171a, same, hypopygial lamella; 172, virginiensis, new species, wing of male; 173, bakeri Cole, wing of male; 173a, same, hypopygial lamella; 174, aurifacies Aldrich, wing of male; 174a, same, antenna of male; 174b, same, hypopygial lamella; 175b, same, wing of female.

PLATE 13.

Figs. 176-187b: 176, imperfectus, new species, tip of abdomen and hypopygium of male; 176a, same, wing of male; 177, vittatus Loew, wing of male; 177a, same, hypopygial lamella; 178, celeripes, new species, wing of male; 179, scapularis Loew, wing of male; 180, domesticus, new species, wing of male; 180a, same, hypopygial lamella; 181, latipes Loew, wing of male; 181a, same, middle tarsus of male; 182, aldrichi Wheeler, wing of male; 182a, same, middle tarsus of male; 183, bolsteri, new species, wing of male; 183a, same, hypopygial lamella; 184, tonsus Loew, wing of male; 184a, same, last three joints of fore tarsus of male; 185, eudactylus Loew, hypopygial lamella; 185a, same, last three joints of fore tarsus of male; 186, versutus, new species, wing of male; 186a, same, last four joints of fore tarsus of male; 187, dakotensis Aldrich, wing of male; 187a, same, hypopygial lamella; 187b, same, last four joints of fore tarsus of male; 187b, same, last four joints of fore tarsus of male;

PLATE 14.

Figs. 188-202a: 188, palaestricus Loew, wing of male; 188a, same, last four joints of fore tarsus of male; 189, batillifer Loew, last four joints of fore tarsus of male; 190, tener Loew, wing of male; 190a, same, last four joints of fore tarsus of male; 191, sicarius, new species, wing of male; 191a, same, antenna of male; 192, scoparius Loew, wing of male; 192a, same, fore tarsus of male from above; 193, quadrilamellatus Loew, hypopygium of male; 194, laciniatus Coquillett, last two joints of fore tarsus of male; 195, occidentalis Aldrich, wing of male; 195a, same, fore tarsus of male; 196, talus, new species, wing of male; 196a, same, fore tarsus of male; 197, coquelletti Aldrich, wing of male; 197a, same, fore tarsus of male; 198, plumosus Aldrich, wing of male; 198a, same, fore tarsus of male; 199, ainsliei, new species, wing of male; 199a, same, hypopygial lamella; 199b, same, last four joints of fore tarsus of male; 200, funditor Loew, wing of male; 200a, same; fore tarsus of male; 201, funditor var. distinctus, new variety, fore tarsus of male, 202, willistonii Aldrich, wing of male; 202a, same, last four joints of fore tarsus of male.

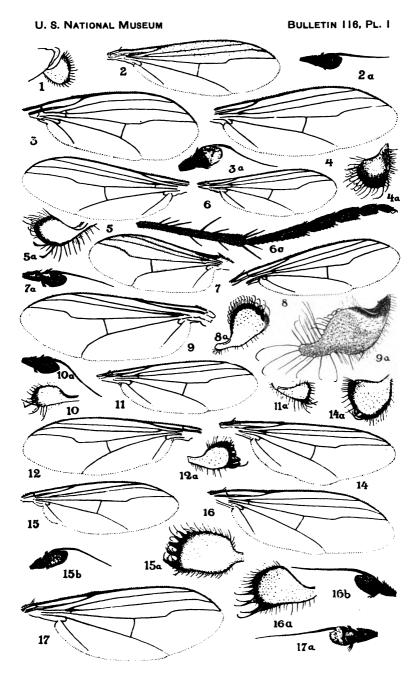
PLATE 15.

Figs. 203-210b; 203, sexarticulatus Loew, wing of male; 203a, same, fore tarsus of male; 204, sphaerietes Brues, last four joints of fore tarsus of male; 205, terminalis Loew, wing of male; 205a, same, fore tarsus of male; 206, canaliculatus Thomson, wing of male; 206a, same, hypopygial lamella; 206b, same, last three joints of fore tarsus of male (inverted); 207, tenuipes Aldrich, wing of male; 207a, same, last three joints of fore tarsus of male; 208, digitus, new species, wing of male; 208a, same, hypopygial lamella; 208b, same, last two and a half joints of fore tarsus of male (inverted); 209, duplicatus Aldrich, wing of male; 209a, same, hypopygial lamella; 209b, same, last four joints of fore tarsus of male; 210 grandis Aldrich, wing of male; 210a, same, hypopygial lamella; 210b, same, last three joints of fore tarsus of male.

PLATE 16.

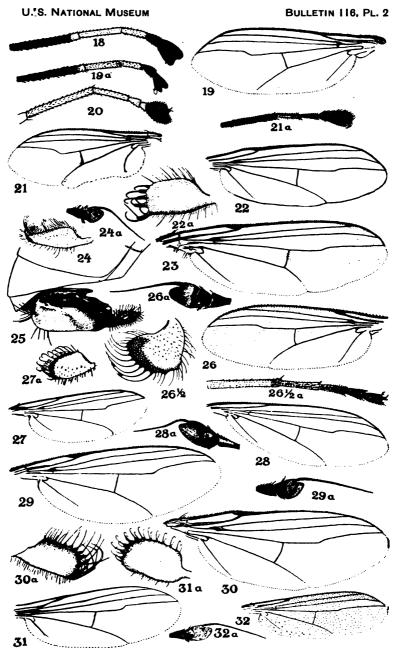
Figs. 211-217: 211, suberbus, new species, wing of male; 211a, same, fore tarsus of male; 211b, same, hypopygial lamella; 212, ruficornis Loew, wing of male; 212a, same, antennae of male; 212b, same, fore tarsus of male; 213, longipennis Loew, wing of male; 213a, same, fore tarsus of male; 214, sarotes Loew, fore tarsus of male; 214a, same, wing of male; 215, cuprinus Wiedemann, fore tarsus of male; 215a, same, wing of male; 216, absonus, new species, fore tarsus of male; 216a, same, wing of male; 217, uxorcula, new species, wing of female (should be No. 130).

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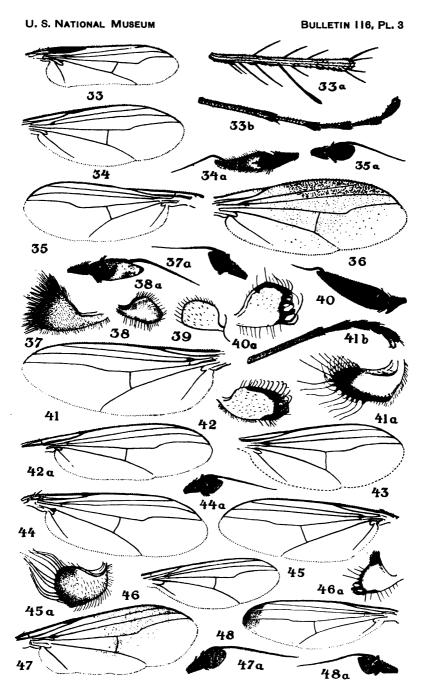
THE DIPTEROUS GENUS DOLICHOPUS IN NORTH AMERICA.

FOR EXPLANATION OF PLATE SEE PAGE 297.



THE DIPTEROUS GENUS DOLICHOPUS IN NORTH AMERICA.

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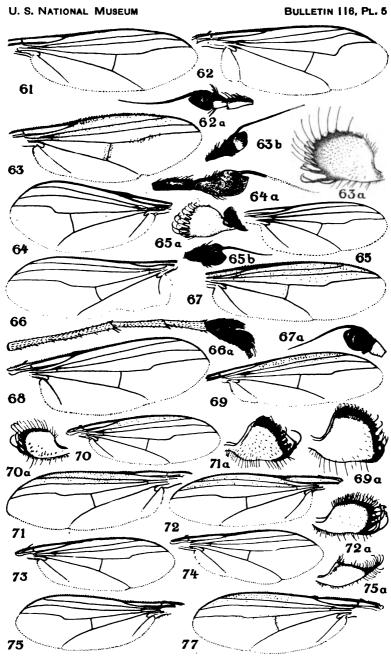


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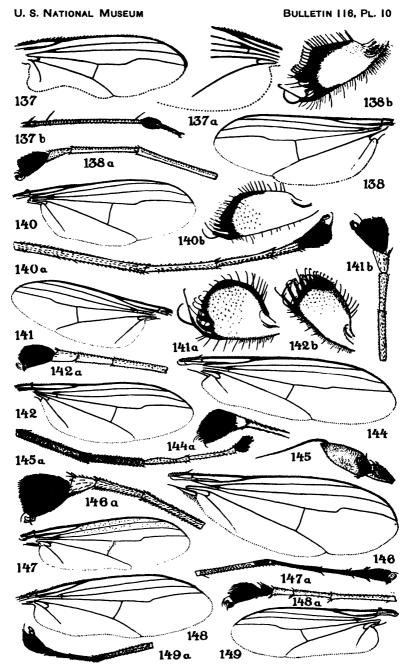
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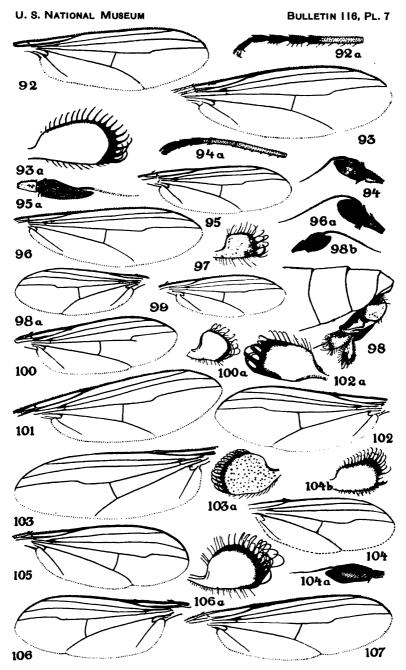
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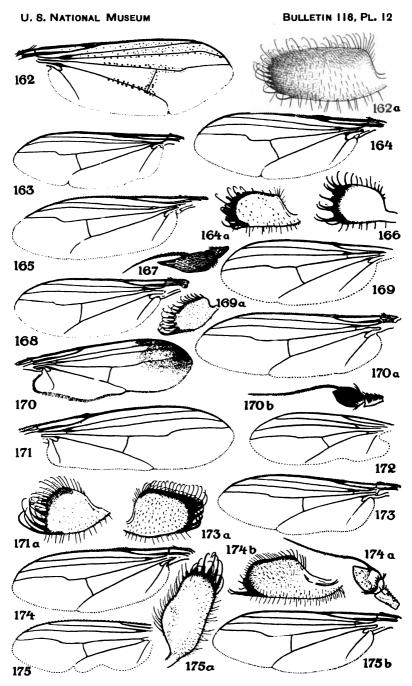
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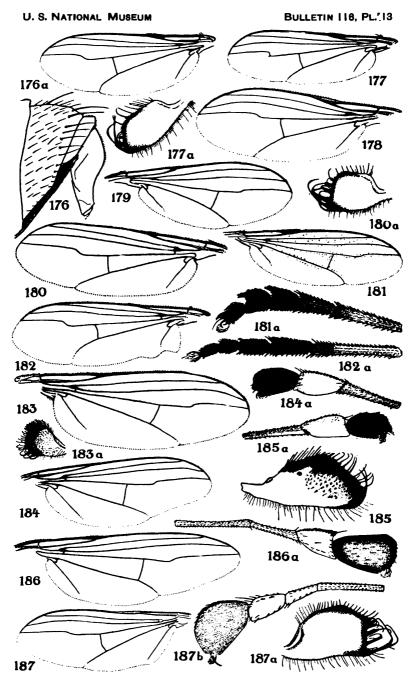
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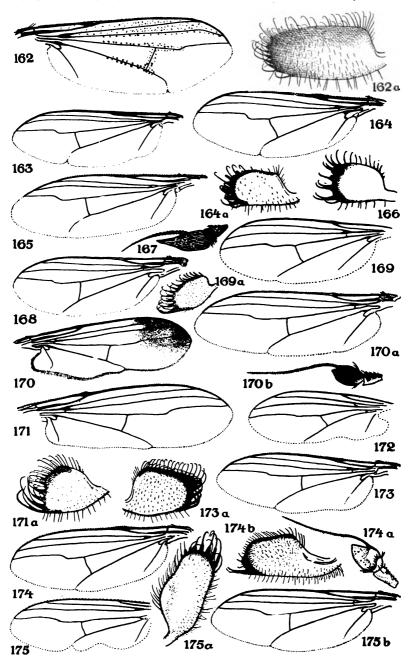
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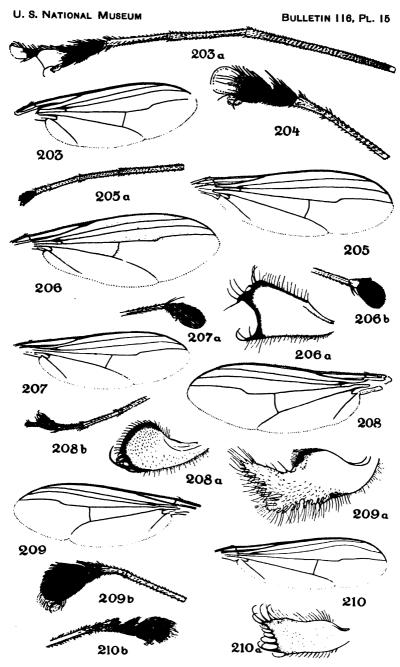
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THE DIPTEROUS GENUS DOLICHOPUS IN NORTH AMERICA.

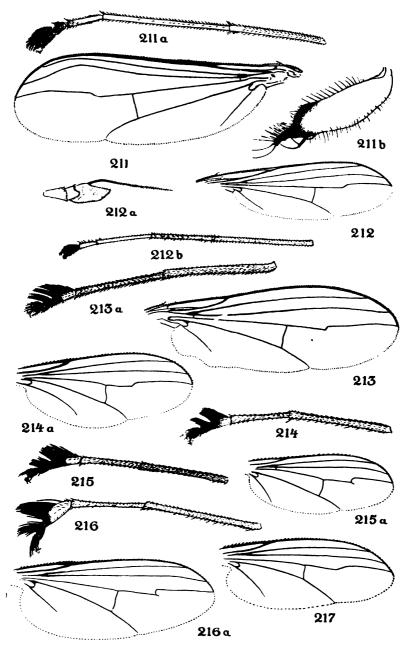
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THE DIPTEROUS GENUS DOLICHOPUS IN NORTH AMERICA.

FOR EXPLANATION OF PLATE SEE PAGE 301.

THE DIPTEROUS GENUS DOLICHOPUS IN NORTH AMERICA.

FOR EXPLANATION OF PLATE SEE PAGE 298.

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SMITHSONIAN INSTITUTION UNITED STATES NATIONAL MUSEUM Bulletin 117

THE DISTRIBUTION OF BIRD LIFE IN THE URUBAMBA VALLEY OF PERU

A REPORT ON THE BIRDS COLLECTED BY THE YALE UNIVERSITY-NATIONAL GEOGRAPHIC SOCIETY'S EXPEDITIONS

BY

FRANK M. CHAPMAN

Of the American Museum of Natural History



WASHINGTON
GOVERNMENT PRINTING OFFICE
1921

Jul. 26, 1921
From
United States Government

ADVERTISEMENT.

The scientific publications of the United States National Museum consists of two series, the *Proceedings* and the *Bulletins*.

The Proceedings, the first volume of which was issued in 1878, are intended primarily as a medium for the publication of original, and usually brief, papers based on the collections of the National Museum, presenting newly acquired facts in zoology, geology, and anthropology, including descriptions of new forms of animals and revisions of limited groups. One or two volumes are issued annually and distributed to libraries and scientific organizations. A limited number of copies of each paper, in pamphlet form, is distributed to specialists and others interested in the different subjects as soon as printed. The date of publication is recorded in the tables of contents of the volume.

The Bulletins, the first of which was issued in 1875, consist of a series of separate publications comprising chiefly monographs of large zoological groups and other general systematic treatises (occasionally in several volumes), faunal works, reports of expeditions, and catalogues of type-specimens, special collections, etc. The majority of the volumes are octavos, but a quarto size has been adopted in a few instances in which large plates were regarded as indispensable.

Since, 1902 a series of octavo volumes containing papers relating to the botanical collections of the Museum, and known as the Contributions from the National Herbarium, has been published as bulletins.

The present work forms No. 117 of the Bulletin series.

WILLIAM DEC. RAVENEL,

Administrative Assistant to the Secretary,

In charge of the United States National Museum.

Washington, D. C., March 19, 1921.

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THE DISTRIBUTION OF BIRD LIFE IN THE URUBAMBA VALLEY OF PERU.

AJREPORT ON THE BIRDS COLLECTED BY THE YALE UNIVERSITY-NATIONAL GEOGRAPHIC SOCIETY'S EXPEDITIONS.

By FRANK M. CHAPMAN
Of the American Museum of Natural History.

INTRODUCTION.

The work of the Yale University-National Geographic Society's Expeditions in the Urubamba region of Peru, under the direction of Prof. Hiram Bingham, has included not only the archaeological investigations which have made the country explored so widely known, but also researches in other branches of science, the whole being designed to form a comprehensive survey of the physical conditions and biological resources of the area under consideration.

The task of making collections in vertebrate zoology was entrusted to the well-known naturalist, Edmund Heller, formerly of the Biological Survey, and the representative of the United States National Museum on the Roosevelt Expedition to British East Africa. The fact should be emphasized that Mr. Heller's first object in the field was the collection of mammals, and every one familiar with the difficulties of mammal collecting in the Andes will appreciate the skill and energy he displayed in amassing a collection of no less than 884 specimens.¹

In collecting birds Mr. Heller attempted to secure species rather than specimens and his collection, therefore, contains a much larger number of forms than its size would lead one to expect.

Mr. Heller was in the field from April to November, 1915, during which time he made collections from the upper limit of life above the La Raya Pass (altitude 14,200 feet) to the dense forests of the humid Tropical Zone in the Rio Comberciato (altitude 1,800 feet). Between these extremes he worked at intermediate points representing every life zone in both its humid and arid aspects. Heller's work in the forests of the humid Temperate Zone at timber line (approximate

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¹ A report on this collection by Oldfield Thomas has been published in the Proc. U. S. Nat. Mus., vol. 58, pp. 217-249.

altitude 12,500 feet) is of special importance. This zone has been previously explored in Peru only in the district about Maraynioc in the Eastern Cordillers somewhat north of the latitude of Lima, where von Tschudi, Jelski, and Kalinowski secured a surprising number of distinct new forms. The rainfall which produces the forest characterizing the humid Temperate Zone is also, in a measure, responsible for our ignorance of its life. The rain creates not only forests, but also rivers, and the river valleys form the natural sites for the trails which connect the highlands and lowlands. When the collector, in following these trails, reaches the region of Temperate Zone forests, his path is far below them and he thus passes under a zone of exceptional interest. I had this experience in the Eastern Andes of Colombia between Bogotá and Villavicencio; while Kalinowski, who collected during several years in the Urubamba region, appears not to have worked in the forests of the humid Temperate Zone, though he lived within a few miles of them.

The authorities of the Yale University-National Geographic Society having honored me by a request to report upon Heller's collection of birds, I decided to alter an itinerary already made for a reconnaissance in South America, on which I was to start four days after this request was received, to permit me to make a hurried journey down the Urubamba Valley as far as Santa Ana. This was done under the auspices of the institutions just named.

Leaving Cuzco with our pack animals on July 1, we returned to that city on July 24, making meanwhile 13 camps in localities representing all the faunal areas of the region, except the humid Temperate and humid Tropical Zones, which the very limited time at my command prevented me from visiting. Unfortunately it had not been possible to make a critical examination of Heller's collections before leaving, or to examine his field notes, nevertheless I realize that without this personal experience, brief as it was, I should not be in a position to prepare even the provisional discussion of the faunal problems of this region which is presented beyond.

I was accompanied on this short expedition by that veteran collector, George K. Cherrie, and by my son, Frank M. Chapman, Jr., and at Tirapata we were joined by Harry Watkins, a resident naturalist who for some years before had been securing birds for the American Museum. Cherrie was the same invaluable lieutenant that he has been on former occasions, and Watkins proved an efficient aid. With the balance left from the appropriation made for this expedition by the National Geographic Society, Watkins was later employed to make collections at La Raya and in the Cuzco district in April, 1917.

Cordial acknowledgement for assistance in the preparation of the paper is due my staff associates, Mrs. A. K. Fraser, Mr. Ludlow

² See Bull. Amer. Mus. Nat. Hist., vol. 36, 1917, p. 55.

Griscom, Mr. W. DeW. Miller, Mrs. E. M. B. Reichenberger, and Mr. Charles H. Rogers. To Mrs. Reichenberger I am especially indebted for a preliminary examination of specimens which greatly facilitated their final determination. I have also to thank Mr. Outram Bangs for the loan of specimens from the collections under his charge, and Mr. L. S. Blaisdell, of Arequipa, and Señor Carlos Duque, of Santa Ana, for courtesies and hospitalities extended to us in the field.

PREVIOUS ORNITHOLOGICAL WORK IN THE URUBAMBA VALLEY.

So far as published records go, our knowledge of the bird life of the Urubamba region is based upon the collections made by Whitely and Kalinowski and reported upon respectively by Sclater and Salvin and von Berlepsch and Stolzmann, references to whose works are included beyond.

Castelnau descended the Urubamba from near Cuzco to the Ucayali in the autumn of 1846, but beyond a reference to the cock-of-the-rock, under the "Vallée de Santa Ana," I find no mention of the bird life of the district here under consideration in his works.

WHITELY'S COLLECTIONS.4

The first bird collector to enter the Urubamba region was Mr. H. Whitely, who, during the course of explorations in southern Peru, extending over a number of years, visited Tinta and vicinity in the upper valley in August, 1868, and the Santa Ana Valley subsequently.

From the first-named region he secured a fairly representative collection, but the collection from the Santa Ana district is far from complete. A list of Whitely's localities in the Urubamba Valley follows:

Tinta (altitude, 11,329 feet).—A small town midway between La Raya and Cuzco. It is in the Puna Zone, but the occurrence of Diglossa brunneiventris and Thraupis darwini lasta indicates that it is not far above the upper limits of the arid Temperate Zone. Whitely collected at and near Tinta from May to August, 1868, securing 131 specimens of 46 species, among them the types of Lessonia niger oreas, Agriornis insolens, and Poospizopsis caesar.

Pitumarca.—A village near and slightly higher than Tinta (altitude, 11,329 feet) in the upper Urubamba Valley, visited by Whitely in 1868. Type locality of Columba albipennis.

Tungasuca.—A village near and slightly higher than Tinta (altitude, 11,329 feet) in the upper Urubamba Valley, visited by Whitely in 1868.

Huiro (altitude, 4,800 feet).—A settlement about 8 miles east of the junction of the Vilcabamba with the Urubamba at Chauillay

³ Hist. du Voy., vol. 4, p. 288.

⁴ See Sclater and Salvin, Proc. Zool. Sec., 1869, pp. 151-158; 1876, pp. 15-19.

Idem.

Bridge. It is evidently in the arid Tropical Zone, most of the 25 species secured here by Whitely being also found at Santa Ana. Type locality of *Thannophilus melanochrous*.

Maramora (altitude 4,000 feet).—A hacienda in the lower Urubamba (Santa Ana) Valley between Chauillay Bridge and Santa Ana. The country is essentially like that about Santa Ana. Whitely secured 22 species here.

Potrero (altitude 4,500 feet).—A hacienda above Santa Ana on the way to Idma. The immediate surroundings resemble those found at Santa Ana. Whitely secured 10 species here.

KALINOWSKI'S COLLECTIONS!

The well-known collector of Peruvian birds, Jean Kalinowski, made a small collection in the vicinity of Cuzco and a larger one in the Santa Ana region. They were reported upon by Berlepsch and Stolzmann who regret their inability to give details of Kalinowski's journey other than the dates at which he visited various localities, and who present no general remarks upon the faunal questions involved. I transcribe the dates published by the authors named.

Cuzco District.—Cuzco, May 13, 1894; January 17, 1898; Urquillos, January 30, 1896; Suriti, May 13, 1894; Luatanay, May 22, 1894; San Geronimo, March 8, 1896; Curahausi, May 10, 1894; Licamachay, May 1, 1894; Vilcabamba, June 27, 1894; June 24, 25, 1895. In all, 13 species are recorded from these localities, the result, apparently, of incidental collecting. Tanagra darwini laeta was described from Cuzco.

Santa Ana District.—Santa Ana, June 2-22, July 5-11, August 28, September 8-22, November 2-22, December 4-19, 1894; Echarati, September 16, 1894; Pacaymayo, June 1, 1894; Idma, June 30, July 1-31, August 2-30, October 11-31, November 2-24, 1894; June 7, 1895; Paltaypampa, November, 1894; June, 1895; Pampa de Derrumbe, June 1, July and October, 1894; Potrero, October, 1894; Puna de Idma, November 24, 1894; Tambillo, September 5, 1895; Casinchihua, May 7, 1894.

Santa Ana itself and Idma were the two principal stations for the 133 species recorded from the district, 56 being taken at the first-named, 75 at the last-named locality. It should be noted that the entry in this paper of "Idma, Sta. Ana," does not mean Idma and Santa Ana, but Idma in the district of Santa Ana. The difference is important, since Idma is in the humid Subtropical Zone. This fact should be especially noted in connection with the list of new forms said to have been described from Santa Ana, only three of the nine mentioned actually having come from that place. They are the

[•] Proc. Zool. Soc., 1876, pp. 15-19.

⁷ See Berlepsch and Stolzmann, Ornis, vol. 13, 1906, pp. 63-66; 73-105.

following: Nothura maculosa peruviana, Myiozetetes similis connivens, and Sporophila gutturalis inconspicua.

The following were described from Idma: Lophotriccus squamaecristatus hypochlorus, Buthraupis cucullata saturata, and Basileuterus signatus. Of the remaining three birds in this list of nine said to have been described from Santa Ana, two are from Chirimoto in the Chachapoyas district of northern Peru, and one from La Merced in the Chanchamayo district east of Lima.

COLLECTIONS OF YALE UNIVERSITY-NATIONAL GEOGRAPHIC SOCIETY'S EXPEDITIONS.

As mentioned above, the Heller Expedition was in the field from April to November, 1915; the Chapman Expedition from July 1 to July 24, 1916; Watkins collected alone from April 3 to 25, 1917, and in 1914 made a small collection for the American Museum near Cuzco. The results of this collecting form the material basis of the present paper and may be summarized as follows:

Number of spe	cimens.
Heller Expedition	757
Chapman Expedition	744
Watkins Expedition	
Watkins's Cuzco collection	
Total number of specimens	1,833

The total number of species recorded by Whitely and Kalinowski is 202. From essentially the same region in which these collectors worked we secured 291 species. Adding to this number the species taken by Heller in the humid Tropical Zone on the Rio Cosireni and Rio Comberciato, a zone the collectors above mentioned did not enter, and 43 species which they secured and we did not, and we have a total of 380 species known from the Urubamba Valley. Further exploration, particularly in the humid Tropical Zone, would greatly increase this number. As a result of three and half years' collecting in a section from the Puna Zone at Lake Junin to the humid Tropical Zone at the eastern base of the Andes, Kalinowski secured 483 species. Adding to these, 66 species taken in the same region by Jelski, but not by Kalinowski, we have a total of 549. This number doubtless fairly represents the avifauna of the region explored, but further work in the humid Tropical Zone would unquestionably increase it. Our work in this zone was only sufficient to show the faunal affinities of our two stations in it. I believe also that the forests of the humid Temperate Zone contain a considerable number of species not represented in our collections, and it is certain that additional species could be secured in the forests of the Subtropical Zone, their density and the physical difficulties of mountain collecting making it far from easy to take a census of their inhabitants.

The collections from the arid Temperate Zone and from the Paramo or Puna Zone are doubtless reasonably complete. In both zones the fauna is comparatively limited and the open nature of the country renders it difficult for birds to escape observation.

DESCRIPTIONS OF COLLECTING STATIONS.

The detailed descriptions of the collecting stations, prepared chiefly by Heller, which are given beyond may be prefaced by an outline which, avoiding repetition as much as possible, may give consecutively the more significant features of the country under consideration as they affect the distribution of bird-life.

As used here, the term Urubamba Valley, is designed to include the district through which the Urubamba River flows from its source at La Raya to its entrance on the forested Amazonian plains at the Pongo de Mainique. Our survey includes not only the shores of the river but the slopes arising from it and crests overlooking it, all (excepting "Occobamba Valley") in Urubamba drainage.

The causes underlying the topography and climatic conditions, both general and local, of this region are fully treated in Bowman's "The Andes of Southern Peru," a work which may stand as a model of objective observation and subjective consideration.

My experience in other parts of the Andes confirms the opinion expressed, I believe, by Professor Bingham, that the Urubamba region contains the most impressive scenery of the entire Andean system. Certainly no other section of this great mountain chain has been more adequately photographed, but, although I was familiar with the results achieved and had seen the best of them as enlargements or lantern-slide projections, they gave me but a faint conception of the magnitude, grandeur, and diversity of the scenery of the region. Any attempt on my part to describe its beauties would therefore be not only foreign to my theme but fruitless.

So gradual is the slope from the shores of Lake Titicaca over the old lake bed to the pass at La Raya, so flat the grass-covered valley floor, that no striking topographic features announce the approach of the divide between Titicacan and Amazonian drainage. Only the accelerated motion of the train as it starts down the steeper grades of the upper Urubamba Valley tells the unobservant traveller that he has passed the highest point (altitude 14,010 feet) in his journey from Titicaca to Cuzco.

The country immediately south of the Pass is dry, upland pasture; but within a few yards north of the Pass one enters an area of marshes, springs, small streams, and lagoons in which the Urubamba River has its origin. The change is abrupt and striking and is accompanied by

American Geographical Society.

a change in the character of the bird-life, evident even from the window of a moving train, geese (*Chloephaga*), ducks of several species, ibis (*Plegadis*), coots (*Fulica*), replacing the occasional flickers (*Colaptes puna*) seen on the Titicacan side. (Pl. 2)

Not a tree, nor indeed any suggestion of bushy growth, is seen; the region is above the limit of cultivation and is typical Puna.

About 20 kilometers north of the Pass, and nearly 2,000 feet below it, barley and low hedges of cactus were first observed, and bushes bordered the streams, indicating that we had reached the very tips of the arms of the arid Temperate Zone which stretch upward into the Puna Zone.

We have had no collecting stations between La Raya and Cuzco, but the presence in Whiteley's collections from Tinta (altitude 11,329 feet), about 12 kilometers north of Sicuani, of *Diglossa brunneiventris*, *Tanagra darwini laeta*, and *Saltator albociliaris* supplies the ornithological evidence of the existence of the arid Temperate Zone at this point.

Near Huambutio the railway leaves the Urubamba to ascend the Rio Huatanay to Cuzco. We did not see the Urubamba again until we reached it at the mouth of the Huaracondo Canyon (altitude 9,800 feet) well within the limits of the arid Temperate Zone. However, Watkins's collections from Pisac (altitude 10,060 feet) and Calca (altitude 9,957 feet), both on the Urubamba, acquaint us with the character of the fauna of the intervening country.

Our route from Cuzco lay slightly north of west through Ttica-Ttica, Puquiura, the Pampa of Anta, and Huaracondo, whence we descended the canyon of that name. (Pl. 3.)

After leaving Ttica-Ttica (altitude 11,900 feet) we traversed a rather flat country with a general elevation of 11,200 feet and bounded by grass-covered rolling hills, broken here and there by barrancas.

The region has been under cultivation for centuries. An occasional tree was seen on the hilltops, but if a forest ever existed here, it has long since disappeared, and the train after train of wood-laden burros which one passes show that the ceaseless demand for fuel is now supplied from farther down the valley.

The hillsides have some stunted, bushy growth which attains the size of small trees along the borders of streams in the barrancas.

Faunally the region is still one of interpenetration of the Puna and arid Temperate Zones, the former occupying the open country, the latter confined largely to the growth in the barrancas, as is described more fully beyond.

Soon after leaving the tableland at Huaracondo we quickly descended 1,000 feet down the trail leading to the bottom of the Huaracondo Canyon where a rushing river offers a suitable home for dippers (Cinclus) and torrent ducks (Merganetta).

The decrease in altitude and the presence of water combine to produce considerable bushy and arborescent growth with a corresponding increase in the number of arid Temperate Zone species. Country of essentially this type (see Heller's descriptions under Chospiyoc and Ollantaytambo) prevailed down the Urubamba Valley until we reached a short distance below Torontoy (which see), where at the bottom of the canyon and on the steep slopes arising from it we saw the first traces of forest growth, and at the same time entered the upper border of the Subtropical Zone.

Paroquets (Aratinga m. mitrata), ant thrushes (Thamnophilus melanochrous), flycatchers (Knipolegus), vireos (Vireosylva j. josephae), warblers (Myioborus m. melanocephalus and Basileuterus luteoviridis signatus), and other characteristic subtropical species suddenly became common, and a single cock-of-the-rock was seen.

From this point the vegetation increased in luxuriance. In places the narrow floor of the canyon was grown with highly developed forest which, unbroken, covered the slopes that were not too steep to permit of tree growth. (Pl. 6.)

The region seemed well adapted to the wants of birds, nevertheless comparatively few were seen and it was only by the most diligent collecting that we secured a fair number of specimens. It should, however, be remembered that the season was midwinter (July) and but few birds were in song. Day broke in almost complete silence. An occasional cassique (Ostinops atrovirens) called, a wood wren (Henicorhina) sang at intervals, but the croak of toucans and the cooing of doves, which form so prominent a part of the morning chorus in the subtropics and humid tropics, were wholly wanting.

Shortly before reaching San Miguel Bridge, at the base of the mountain on which lie the ruins of Machu Picchu, made known to the world by Professor Bingham's explorations, the luxuriant forest growth disappears and we quickly pass into the upper border of the arid tropics with its low scrubby growth in which acacias and cacti characterize the vegetation and Tapera naevia and Thraupis episcopus the birds. (Pl. 5.)

Santa Ana, the end of our journey down the valley, is in the heart of this arid Tropical Zone, which extends at least to Echarati where the forest of the humid Tropical Zone is said to begin. This we did not reach and our only collections from it were made by Heller at Rio Cosireni and Rio Comberciato about 50 miles below Echarati.

From Santa Ana we ascended the mountain slopes to the Subtropical Zone at Idma, finding there essentially the same species as occur in this zone above San Miguel Bridge.

The more detailed description of our collecting stations follows:

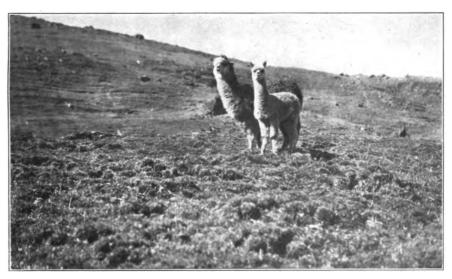
La Raya (altitude 14,010 feet, Puna Zone).—The pass at La Raya on the railroad to Cuzco marks the divide between Titicacan and

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HEADWATERS OF THE URUBAMBA RIVER AT LA RAYA PASS.
Altitude 14,150 feet. Puna Zone. Photographed by Chapman, June 30, 1916.



OCCOBAMBA PASS.
Altitude 13,800 feet. Puna Zone. Photographed by Heller.

Amazonian drainage. The ascent from the Titicaca Basin is very gradual; the descent toward Cuzco is more rapid, the last 30 kilometers of the ascent giving an increase of only 412 meters as compared with a fall of 647 meters for the first 30 kilometers beyond the divide.

The Urubamba River has its origin in the marshes and lagoons which lie immediately below the Pass. (Pl. 2.)

While at and near La Raya, November 9-25, 1915, Heller collected only mammals and our collection of birds from that place was made by Watkins. Beyond such widely distributed species as Nycticorax naevius, Falco fusco-caerulescens, Brachyspiza capensis peruviana and some others, the species secured are characteristic of the Puna. The following description of the region was written by Heller:

La Raya Pass is an open, level-floored valley, grass-covered and dotted by small lagoons and marshy streams. Bounding the valley floor are rounded, grass-covered hills, and in places rocky ridges rising to a height of 2,000 or 3,000 feet. To the east of the Pass a view of snow-capped peaks, their sides furrowed by glaciers, may be obtained, but to the west the ridges are lower and without permanent snow fields.

The temperature here was decidedly cool, or even bitter, during the day when the wind was blowing, and at night there was hoar frost. During our stay in November we were visited every evening about sunset by a violent thundershower of an hour's duration. The storm usually resolved itself into a hail or sleet affair accompanied by a heavy artillery of thunder and flashes of lightning which swept over the land-scape until dark. The days were bright with sunshine and as a rule calm, but the temperature was always bracing, although the sun was powerful enough to melt the light coating of sleet of the previous night's storm.

The region of La Raya is quite treeless and to all appearances bushless as well. Tussocks of coarse bunch grass with sharply spiked blades are the all-pervading floral feature. Other species of more tender grasses, on which the flocks of llamas and alpacas feed, grow with these, but they are much less conspicuous. Matlike clusters of small brilliantly green herbs grow in the damp meadows, but such are quite grasslike in general appearance. On the rocky hillsides amid the shingle and gravel are four-1 clumps of a yucca or Spanish bayonet with whorls of gray spiny leaves and tal ...ied flower stalks of past seasons still standing. A cactus, a small white silky cereus, grows sparingly at this altitude. One of the few flowering plants seen here was a nettle-leaved herb bearing showy, poppy-red flowers. A few inconspicuous flowers of anemone-like appearance were seen in the meadows. High up on the hillsides a few verdant bushes were encountered, but they were very local in distribution.

Watkins' Expedition, April 3-13, 1917, 142 specimens of 40 species. *Pisac* (altitude 10,060 feet, junction of arid Temperate and Puna Zones).—A town in the Urubamba Valley about 7 miles northeast of Cuzco.

Watkins' Expedition, April 17-20, 1916, 65 specimens of 23 species. Calca (altitude 9,957 feet, junction of arid Temperate and Puna Zones).—A town in the Urubamba Valley near Urubamba with essentially the fauna of the Cuzco district.

Watkins' Expedition, April 21-25, 1917, 34 specimens of 23 species.

Ttica-Ttica (altitude 11,900 feet, junction of arid Temperate and Puna Zones).—The first camp of the Chapman Expedition was just off the Incan highway which leaves Cuzco through the Ttica-Ttica Pass, and about 3 miles west by north of that city. It is a region of hills, valleys, and barrancas devoted to grazing and the growing of barley. Although our visit was made in the heart of the dry season, there was still some water in the stream beds of the deeper barrancas. At the bottom and on the sides of these barrancas and in the smaller, tributary quebradas, there was more or less low, bushy growth. This growth here marked the upper limit of the arid Temperate Zone, while the grass-covered areas supported the avifauna of the Puna.

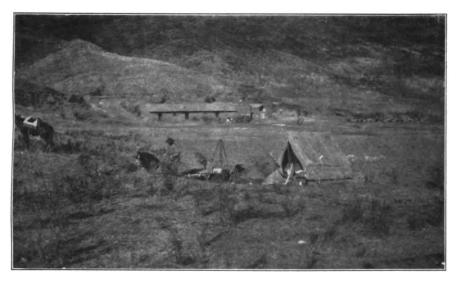
At 6 o'clock in the morning the mercury at this camp registered 30° F. (Pl. 3.)

Chapman Expedition, July 2 and 3, 1916, 55 specimens of 21 species. Huaracondo Canyon (junction of arid Temperate and Puna Zones).—A narrow, steep-walled canyon about 10 miles long, carved by the Huaracondo River from Huaracondo (altitude 11,200 feet) to the Urubamba River (altitude 9,800 feet). Its floor supports considerable bushy and arborescent vegetation, well described by Heller, who collected here at Chospiyoc (which see). Our camp was at "Pumatales," the hacienda of Señor Silva, at an altitude of about 10,000 feet, and apparently near the point at which Heller worked.

At 6 o'clock in the morning, July 23, the mercury registered 32° F. Chapman Expedition, July 23, 1916; 55 specimens of 23 species. Chospiyoc (altitude 10,000 feet, junction of arid Temperate and Puna Zones).—Heller's station in the Huaracondo Canyon, evidently near the point at which the Chapman Expedition stopped for one day. The following description was written by Mr. Heller:

The canyon of the Huaracondo River extends from the village of that name to the Urubamba Valley, where the river mingles its waters with the Rio Urubamba. Half-way down the canyon is situated Chospiyoc, a collection of cultivated fields, a hut, and a rickety bridge consisting of two crooked logs spanning the stream. The canyon is a perfect V-shape, with steep sides and a narrow floor occupied chiefly by the stream. Chospiyoc lies at 10,000 feet altitude, and the precipitous sides of the canyon rise above it some 3,000 feet to the general level of the Andean ranges here. The walls throughout all this half mile of vertical depth are alluvial deposits of gravel and clay, with no rock masses of large extent in place. The boulders lining the creek margin are many colors—white marbles, gray limestones, blackish slates, red porphyries, and many others.

Our camp was pitched near the bridge, but across the stream from the cultivated fields of maize and wheat. During our stay here, in the latter part of April, the peach and apple trees were laden with ripe fruit, and the grain was also quite mature. The climate is quite dry at this point, most of the moisture falling at the higher altitudes on the summits of the ridges, where the clouds are held. Rain was falling abundantly at night in the region drained by the Huaracondo River, which was a terra-cotta red flood loaded with sediment from the adobe soil. The temperature at Chospiyoc is temperate, the days are pleasant and the nights cool, but not bitter. The natural tree flora is quite extensive in species, but trees are nowhere numerous.



CAMP AT TTICA-TTICA.

Altitude 12,000 feet. Open country, Puna Zone; bush-grown "quebradas," arid Temperate Zone.
Photographed by Chapman, July 3, 1916.



HUARACONDO RIVER AND (IN THE DISTANCE) TOWN.

Altitude 10,850 feet. Ducks, geese, ibis, gulls, and other Puna Zone species were common here. Photographed by Chapman, Jr., July 4, 1916.



HUARACONDO CANYON AT ITS ENTRANCE TO THE URUBAMBA CANYON.

Altitude 9,400 feet. Arid Temperate Zone. The trees in the distance are eucalyptus. Photographed by Watkins.



LOOKING DOWN THE URUBAMBA RIVER, TOWARD MOUNT SALCANTAY, AT OLLANTAYTAMBO.

Altitude 9,300 feet. Arid Temperate Zone. Photographed by Chapman, July 5, 1916.

Straggling willows and alders line the river margins, beneath which are smaller bushes of many sorts, but there are no groves or clump of trees. On the flat land and lower hill-slopes a few stunted pepper trees carry on a brave struggle for existence against the ax of the wood gatherers.

Much of the valley floor is covered by a growth of composite bushes of the genus *Baccharis*, which are the chief thicket-forming shrubs. On the drier slopes far above the creek the yucca or Spanish bayonet clings to the gravelly banks, and at rare intervals a giant cactus, a species of *Cereus*, stands conspicuous and grotesque amid the bushes and rocks. The smaller spiny tree cactus is also found here, as well as numerous other spiny bushes, such as the barberry, *Berberis flexuosa*, *Colletia spinosa*, and *Schinus dependens*. (Pl. 4.)

Heller Expedition, late April 14-23, 1915; 34 specimens of 19 species.

Ollantaytambo (altitude 9,300 feet, arid Temperate Zone).—This station lies in the arid Temperate Zone, the bushy and arborescent vegetation found here on the valley floor offering a home for such characteristic species of this zone as Anaeretes flavirostris, Saltator albeciliaris, and Diglossa brunneiventris. Here, as we descended the valley, we found the last evidences of the Puna Zone in Colaptes puna and Cinclodes fuscus rivularis. (Pl. 4.)

Mr. Heller supplies the following notes on this station, at which the Chapman Expedition collected only on July 5:

One of the ancient Inca strongholds was the city of Ollantaytambo, situated some 10 leagues northwest of Cuzco in the Urubamba Valley at an altitude of 9,300 feet. At this point the valley has great depth, the river having cut its way through the eastern cordillers of the Andes. On either side tower great cliffs to a height of 4,000 feet or more, their summits splintered into many fantastic shaped pinnacles. The rock formation is chiefly a yellowish flinty shale; in the immediate vicinity, but across the river, on the western side of the valley, are areas of reddish granite, black slates, and other rocks. The position of the town was secure against invasion, except along the valley approaches of the Urubamba and the tributary stream of Ollantay-tambo Creek. In the neighborhood of the town the valley floors have been converted into great level terraces of a rich, black soil, free of rocks, which is devoted to the cultivation of maize and wheat chiefly. The climate is quite dry, and to provide against crop failures a series of canals for carrying water to the fields have been in use here since ancient times.

Ollantaytambo was our base station, and thither I returned at intervals during my eight months of field work. During April the rainy season draws to a close, rain falling in the night and then only in intermittent showers. May and June are bright, clear months, but July furnishes a few showers, which again give way to a dry season in August and September. Rain in considerable quantities falls in October, and the country under these deluges blossoms verdant as our own spring in the north. We may consider April to May the fall, July midwinter, owing to its greater cold, and October a spring month, to continue the comparison. There are, however, peculiar contradictions in the actions of some cultivated plants. Upon our arrival at Ollantaytambo in early April the peach and cherry trees were in blossom, as well as bearing nearly ripe fruit, apparently making a brave attempt to combine spring and fall. The native mountain-side shrubs, however, did not blossom as a unit until October, when the giant cactus, Cereus, and herbs generally put forth their floral efforts. Some of the native plants, such as the golden-flowered Spanish broom and Stenolobium

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bushes, blossomed in April and May. During the dry months the nights were cold, often bitter, the days bright and fresh, accompanied by a strong daily breeze up the valley, lasting from noon until sunset. The mountain slopes which wall in the city of Ollantaytambo have a decidedly arid appearance, the scattered vegetation of cactus and stunted bushes being far from adequate to cover the brown rocks and soil. Bordering the stream is a scattered growth of willows, alders, cherry trees, Stenolobium, a saxifrage tree (Escallonia), Spanish broom, Baccharis bushes, and others. Well above the valley the slopes and ridges support various grasses.

Heller Expedition, April 25; July 20-August 14; November 7-12, 1915; Chapman Expedition, July 5, 1916; 68 specimens of 27 species. Occobamba Pass (altitude 13,800 feet; camp, 12,500 feet, Puna Zone).—The few specimens collected by Heller in this locality show, as might be expected, that it is in the Puna Zone. The species represented include our only specimens of Thinocorus orbignyanus and Theristicus branickii as well as examples of Chloephaga melanoptera, Nettion oxypterum, Colaptes puna, Geossitta tenuirostris, Phrygilus unicolor, etc.

Heller's description of this station follows:

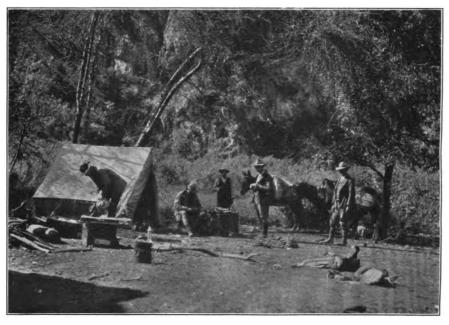
We have applied the name Occobamba Pass to the pass leading from the head of the Ollantaytambo Valley to the Occobamba Valley. The Occobamba Pass is traversed by a well-made road over which considerable traffic is carried annually. The pass lies some eight leagues north and above Ollantaytambo and has a summit altitude of 13,800 feet, by aneroid measurement. The rugged, mountainous character of most Andean passes is quite wanting here, and it is a great relief to find such a region as this, with gently sloping, rounded hills and wide shallow valleys. In the neighborhood of the pass the country has the appearance of a rolling prairie on a gigantic scale.

The hills, when we visited the region in July, were covered by a thick bowth of dried grass as far as the eye could see. No nude rock surfaces, no snow field a no tree growths were visible; all was a rolling sea of brown grass. The climate is dry compared to the forested montaña country farther north, but the pass receives considerably more rainfall than Ollantaytambo owing to its greater elevation and proximity to the summit. ridges. During our stay in July the weather was very cold, the coldest we experienced in Peru. The nights were bitter cold, freezing the margins of running streams as well as vessels of water actually inside the tent. The mornings, though sunny, were cold, until 9 a. m., and the climate was bracing even at midday. Shrubs and conspicuous herbs were quite lacking here. The bushy growth bordering the stream ceases at 12,500 feet altitude. Rock surfaces were seen in some of the higher tributary valley above the limits of vegetation, where a variety of formation of slates, shales, basalts, and granites were noted, but in the main valley disintegration had gone very far, all the hills being soil-covered, and supporting a growth of grass. In the neighborhood of villages, at altitudes of 11,000 to 13,000 feet, potato culture is extensively engaged in, the soil being rich black loam. Most of the valleys are, however, devoted to grazing herds of llamas, alpacas, sheep, horses, and mules.

Heller Expedition, July 20, 21, 1915; 10 specimens of 12 species.

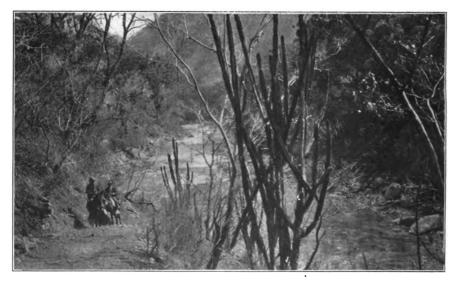
Occobamba Valley (altitude, 9,100 feet, humid Temperate Zone).—One of Heller's stations above Ollantaytambo. The presence here of Grallaria rufula obscura, Heliochera cristata, Diglossa personata melanopis, and Conirostrum cinereum cinereum indicates that it is in the humid Temperate Zone, apparently at its lower margin. Heller's description of this locality follows:

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CAMP AT ASTILLERO BELOW TORONTOY.

Altitude 7,800 feet. Near the upper limit, on the canyon floor, of the Subtropical Zone. Photographed by Chapman, July 6, 1916.



URUBAMBA RIVER ABOVE SANTA ANA.

Altitude about 3,600 feet. Arid Tropical Zone. Photographed by Chapman, July 17, 1916.

Well down in the Occobamba Valley, at a point where the forested country meets the grassy uplands, we established our camp, at a spot called Tocopoqueyu. The camp was pitched in one of the terraced fields on the west bank of the creek, at an altitude of 9,100 feet. During our sojourn here in July the weather was bright and warm during the day and cool at night, but seldom bitter or windy. The country has a peculiar physical aspect, owing to one side of the valley, the eastern, being clothed by a dense forest, and the opposite, or western, being the very antithesis; that is, grass-covered and dry in character. The forest edge is definitely bound by the stream margin, which is lined by a growth of alder and willow trees. The alders here form a considerable part of the forest, and such as are found growing at a distance from the stream have widespread crowns and a grayish appearance seldom seen in riverside trees. Other forest trees are Eugenias, or cloves, Escallonias, and a large bay tree of the genus Myrica. Bamboo, as usual, forms a dense undergrowth in the forest.

The direction and constancy of the prevailing winds here seem to offer an explanation for the extraordinary difference in vegetation on opposite sides of the valley. The moist breezes coming up the valley from the hot lower montaña country are mistladen and confined to the eastern side, along which the mist hangs, leaving the western side open, sunny, and dry. The fauna partakes of this divided character also, the forested side being the haunts of such marsupials as Oriolestes, Peramys, the pygmy opossum, Didelphis, and many species of forest rodents. On the west side we find white-tailed deer, coyotes, skunks, and rodents peculiar to the grassy Andean Zone. The country rock is granite, cliffs of which are exposed for several miles on the western side. (Pl. 2.)

Heller Expedition, July 23-Aug. 2, 1915.

Torontoy (altitude 8,000 feet, Subtropical Zone).—In descending the Urubamba Canyon the upper limit of the Subtropical Zone is encountered at Torontoy where the first evidences of forest are seen. Cactus, acacia, and other xerophytic forms are replaced by begonias and bananas and plantains, and such typical subtropical birds as Thamnophilus melanochrous, Henicorhina l. leucophrys and Myioborus m. melanocephalus soon became common. The Chapman Expedition camped at Astillero a short distance below the settlement of Torontoy where the growth is more luxuriant than at Torontoy. (Pl. 5.) Heller's observations are appended:

At the entrance to the canyon of the Urubamba stands Torontoy, once an important Inca stronghold. To-day we find a collection of Quichua huts set in the unlovely environment of pig wallows, and the abiding places of mules, goats, chickens, dogs, and other domestic creatures. Fields of maize cling to the steep sidehills on both sides of the valley, and above these extend the grass-covered slopes on which the herds graze. The altitude at Torontoy is approximately 8,000 feet, and the climate is mild and pleasant. Part of the year, December to May, is rainy, but much of the time there is fine, dry weather, without the fog conditions which prevail on the higher forested ranges guarding the valley. The rock formation is largely granite of a light grayish color. Cliffs of this material are seen bordering the river at various places, but the greater part of the country is grass-covered or else forested.

The Urubamba Valley at Torontoy is a deep V-shaped gorge some 3,000 or 4,000 feet deep, narrowing into a canyon immediately below this point. The scenery throughout the district is bold and carried out on a grand scale. Beyond the confining ridges of the valley occasional glimpses of snowy peaks, which mark the main cordilleras of the Andes, may be obtained.

Growing at the river margin are alder and willow trees, forming a sort of border. The valley floor generally and the lower hillsides are bush-covered by the yellow-flowered Stenolobium, small Escallonia trees, pepper trees, giant cactus of the genus Cereus, tree-like Opuntia cactus, yuccas, and a host of peculiar floral forms.

Heller Expedition, May, 1915; Chapman Expedition, July 10, 1916; 90 specimens of 33 species.

Above Torontoy (Altitude, 9,500-12,000 ft., humid Temperate Zone).—This region lies wholly within the humid Temperate Zone. It was visited by Heller largely in search of mammals, but the birds secured show its faunal affinities to be with those of Cedrobamba. Heller describes it as follows:

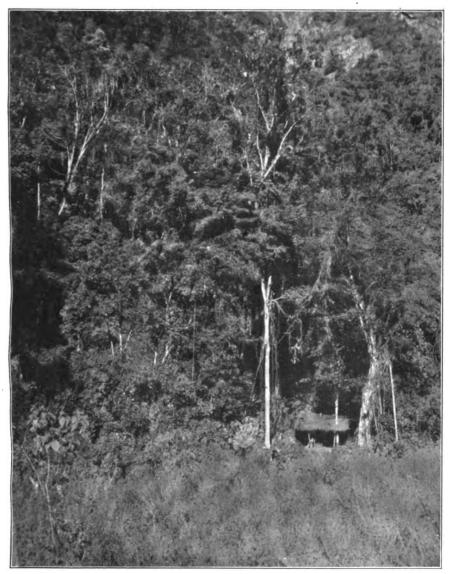
The Urubamba Valley at Torontoy is unforested, but the mountain slopes of the eastern side far above the ancient villages are clothed by dense primeval forest to the limits of snow and glaciers. In this elevated forested region I established two camps, one at timber line on the steep mountain slope, at an altitude of 12,000 feet, and the other in the heart of the forest in a broad, level part of the creek valley, at 10,500 feet elevation. The mountain side at timber line was so steep that it was found necessary to dig out a platform large enough for the foundation of the 8 by 10 foot tent which I carried. The camp was pitched on a forested ridge, one side of which was bounded by a stream, and the other by a shallow ravine occupied by a grizzled glazier of small extent which terminated not far below. The nights were bitter cold, and when the sky was unclouded the ground at dawn was white with a heavy frost. The days as a rule were misty, but seldom rainy, the mist being of a dripping, saturating sort, quite as effective as rain. Early in the morning before the mists had rolled up as high as timber line, a magnificent view of the snow peak of Salcantay and the high ranges over which it dominates could be seen across the cloudfilled valley of the Urubamba.

The forest vegetation of the timber-line area near camp was made up principally of three features; tall bamboo thickets, trees, and the shorter grassland of the Andean Zone. Accena trees grew to immense size here, some of them being 8 feet in diameter. Much of the very highest forest was made up of small Gynoxys trees of uniform size and free from bamboo or undershrubs. The ground in these forests was carpeted by a heavy coat of elastic green moss into which we often sank ankle-deep, while the tree trunks and branches were festooned by loads of gray and black lichens. The rock formations in the immediate vicinity of camp were hidden by the vegetation, but the higher slopes above the limits of vegetation appeared to be dark gray slates in composition.

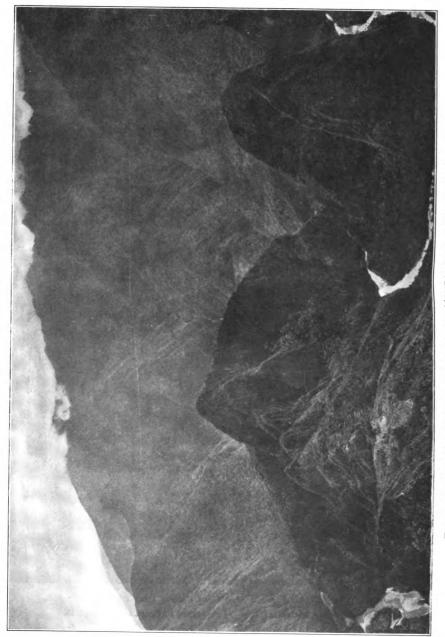
The central camp was established in the middle of a wide part of the valley of Torontoy Creek at 10,500 feet altitude at a place where the original trail-builders into this unknown forest had erected a temporary hut a few months previously. The stream ran beside the camp over a pebbly bed, limpid, cold and almost tranquil. On all sides the forest spread completely filling the valley and ascending the steep slopes to the lower limits of snowfields at the summit. The trees in character differed somewhat from those at timber line, the number of species being considerably greater and the undergrowth of bushes and bamboo much more luxuriant. The ground moss and open character of the upper forest was quite wanting. The climate was milder. At night it was cool, but no frost occurred.

Heller Expedition, May, 1915; 47 specimens of 24 species.

San Miguel Bridge (altitude, 6,000 feet, Subtropical Zone).—An important collecting station for both the Heller and Chapman expeditions. The river bottom here lies at the lower border of the



FOREST IN BOTTOM OF THE URUBAMBA CANYON ABOVE SAN MIQUEL BRIDGE.
Altitude about 6,200 feet. Subtropical Zone. Photographed by Chapman, July 19, 1916.



The ruins of this city lie on the ridge in the foreground. San Miguel Bridge (altitude 6,000 feet), a base of both Heller and Chapman Expeditions, crosses the Urubamba River a short distance below the point shown in the lower left-hand corner. Photographed by Bingham. FORESTS OF THE SUBTROPICAL ZONE IN THE URUBAMBA CANYON AT MACHU PICCHU.

Subtropical Zone, and a short distance below the bridge one passes into the arid Tropical Zone. Above the bridge and for the greater part of the way to Torontoy, the mountain slopes, and favorable places at the bottom of the canyon are covered with a highly developed, luxuriant cloud forest, the home of such characteristic species of the humid subtropics as *Pharomachrus auriceps* and *Rupicola p. peruviana*. (Pl. 6.)

Mr. Heller's description of this locality is appended:

Immediately below Machu Picchu, on the floor of the valley, is the Bridge of San Miguel, over which passes all the traffic between Cuzco and the lower part of the valley. At this point the walls of the valley rise perpendicularly for 3,000 or 4,000 feet, and in some places, such as opposite the base of Machu Picchu, the walls are 5,000 feet high. The stream margin of the waters for a short distance above the bridge is bordered by wide, gravelly bars and forest-grown flats of river alluvium. The bridge stands at 6,000 feet altitude and enjoys a singularly mild and equable climate. The nights are delightfully cool and the days are semitropical. Much of the canyon at this point is shaded from the direct rays of the sun part of each day by towering cliffs which rise vertically from the floor. A great variety of tree growth occurs along the stream and the sides of the valley where talus slopes offer a foot-hold for vegetation. The largest of the trees is one of the Leguminosae of the genus Erythrina which bears a profusion of carmine flowers. This tree is found scattered through the forest bordering the river: its great swollen trunk and wide-spread crown giving it a peculiarly distinct appearance. Upon talus slopes and new ground generally grow clumps of the graceful trumpet-trees, Cecropia, the drooping, lobed, peltate leaves giving them a graceful distinction. Killer figs, with strangling limbs and roots fastened to the wall of cliffs or growing as epiphytes on the trunks of other trees, rear themselves in every available nook. A common riverside tree is the pacay, bearing spherical heads of flowers which are a favorite source of food for hummingbirds. Small ferns of many kinds abound in the shade of other trees. Both bamboo and palms are wanting in the immediate neighborhood of San Miguel Bridge. The common trees bordering the stream or growing on the alluvial flats were willows and alders. (Pl. 7.)

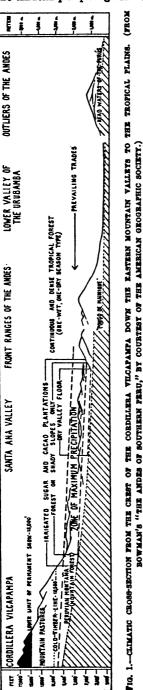
Heller Expedition, June 17-July 10, 1915; Chapman Expedition, July 7, 18, 19, 1916; 269 specimens of 74 species.

Cedrobamba (altitude 12,000 feet, junction of humid Temperate and Puna Zones).—Although Heller collected only 54 specimens at and near Cedrobamba they form, from a faunal standpoint, the most important part of the entire Urubamba collection. Of the 30 species represented, 18 were not found elsewhere, while 8 of the remaining 12 were found only in the Occobamba Valley or above Torontoy, localities which evidently lie in the zone (humid Temperate) which finds its upper limit at Cedrobamba. (Pl. 8.)

Heller's description of this locality is appended:

The high and narrow ridge upon which the ancient city of Machu Picchu is situated rises in a series of undulations to the southward, the first wave being the peak of Machu Picchu, a second Ccorihuayrachina, and the third in a northerly direction the ridge on which stand the ruins of Cedrobamba. The camp at Cedrobamba, which had an altitude of 12,000 feet, was placed a hundred feet below the ruins at the head of one of the tributaries of the Rio Acobamba, a rushing mountain torrent which adds its waters to the Urubamba a mile below San Miguel Bridge. Cedrobamba is situated

exactly on the parting of the great forest of the Amazonian Basin and the grassland of the Andean pampa region. The forest at this place stops as abruptly as if cut by a



knife, quite as sharply as a hedge row on the borders of a lawn; long tongues of forests in places, however, follow up the creek margins or ascend favorite slopes to a thousand feet beyond the general forest limits. There is no dwarfing of trees or diminution in their numbers on the borders. A variety of trees grew at the timber-line edge. There were shaggy barked Acaena ochreata trees with drooping masses of gray-green foliage, small, erect Gynoxys trees with their dome-shaped crowns adorned by golden composite blossoms, a whitebarked Melastomataceous tree of the genus Miconia towered above all with its spidery branches spreading in every direction. A small, stout-trunked fern, an arborescent Lomaria, was a constant feature of the forest edge. Bamboo grass (Chusquea quila) in some places intertwined its light green stalks with the trees, but it was chiefly along the borders of streams and on swampy soil that it flourished. Mosses and lichens of many colors and sorts smothered the tree trunks and branches, making them in appearance many times their actual size. The gray-beard lichen was the prevalent one on the terminal parts of the branches, and another, a deep black species, confined its affections to the trunks and larger branches. Beyond the forest a luxuriant growth of grass covered the mountain slopes, mingled with which, but in close proximity, were small huckleberry bushes, Baccharis bushes and a few tall herbs. Cedrobamba climatically was damp and cold. It was at the edge of a more or less permanent fog bank, the limits of which seemed to coincide with that of the forest.

Rain in great quatities apparently does not fall here, but the region is constantly bathed in cold mists. The nights are cold but seldom bitter, the daily extremes of temperature being considerably less than in the drier region farther inland of equal elevation.

Heller Expedition, May 23-June 15, 1915; 54 specimens of 30 species.

Santa Ana (altitude 3,480 feet, arid Tropical Zone).—The valley of Santa Ana is a semi-arid tropical pocket shut off from the heavy rainfall of the true Amazonian region by the range of the Andes which lies to the eastward of it. Bowman opposents a diagram (here reproduced) of the climate of the eastern slope of the Andes and writing of Santa Ana says:

It will be seen that the front range of the mountains is high enough to shut off a great deal of rainfall. The

The Andes of Southern Peru, p. 79.



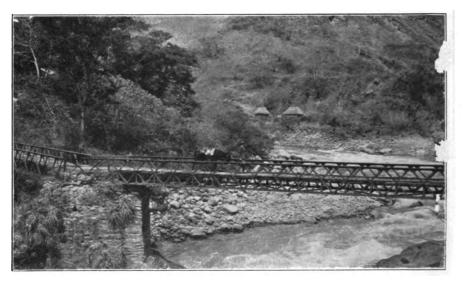
TIMBERLINE NEAR CEDROBAMBA.

Altitude about 12,500 feet. Junction of humid Temperate and Puna Zones. Photographed by Bingham,
May 11, 1915.



FORESTS NEAR CEDROBAMBA.

Altitude about 12,000 feet. Humid Temperate Zone. Photographed by Bingham, May 12, 1915.



CHAUILLAY BRIDGE OVER THE URUBAMBA RIVER.
Altitude 3,700 feet. Arid Tropical Zone. Photographed by Chapman, July 9, 1916.



SANTA ANA VALLEY, LOWER URUBAMBA VALLEY.
Altitude 3,500 feet. Arid Tropical Zone. Photographed by Chapman, Jr., July 16, 1916.

lower hills and ridges just within the front range are relatively dry. The deep valleys are much drier. Each broad expansion of a deep valley is therefore a dry pocket. Into it the sun pours even when all the surrounding hills are wrapped in cloud. The greater number of hours of sunshine hastens the rate of evaporation and rill further increases the dryness.

The influence of the local climate upon tree-growth is striking. Every few days, even in the relatively dry winter season, clouds gather about the hills and there are local showers. The lower limit of the zone of clouds is sharply marked and both at Santa Ana and Echaratí it is strikingly constant in elevation—about five thousand feet above sea level. From the upper mountains the forest descends, with only small patches of glade and prairie. At the lower edge of the cloud zone it stops abruptly on the warmer and drier slopes that face the afternoon sun and continues on the moister slopes that face the forenoon sun or that slope away from the sun.

It may be added that this cloud forest, which so strongly characverizes the Subtropical Zone, descends in drainage areas considerably below the 5,000-foot level—a condition clearly illustrated by a photograph of the western slope of the Central Andes of Colombia published in my Distribution of Bird Life in Colombia.¹⁰ The climate of the Cauca Valley, it may further be said, is due in a large measure to the causes which create semi-aridity at Santa Ana.

Santa Ana is historic in the annals of Urubamba ornithology. Formerly the site of a Jesuit Mission it is now a hacienda devoted to the production of sugar cane and coca where the unbounded hospitality of the proprietor, Señor Duque, the delightful ctimate, the ease with which adjoining areas may be reached have induced practically all the naturalists and explorers who have visited this region to make it, for a time, their headquarters.

Kalinowski collected here at intervals from June to December, 1894, securing, according to Berlepsch and Stolzmann 11, examples of 56 species. Various members of the Yale University-National Geographic Society Expedition also stopped at Santa Ana, including Heller, whose notes on the region are here appended:

The valley at Santa Ana is particularly wide, fully a league, and the confining slopes are gentle, although they rise to considerable heights and give the valley a deep effect. Owing to the great width of the valley, and the distant position of the summit ridges, the rain clouds do not collect at this point but pass on and hang themselves to the higher slopes beyond. While we were at Santa Ana in October, the days were bright and clear, but not far distant could be seen the rain clouds and storms in progress and occasionally the thunder reached our ears. The valley floor is covered by a black humus soil, and devoted largely to coca culture, but cane fields are numerous, and, at certain seasons, maize also. The valley slopes show a red soil where they are not grass-covered. Bordering the river are groves of the graceful algaroba trees, the timber of which has been used in the construction of the hacienda buildings which were originally designed for the purpose of a mission station. Cecropia and Erythrina trees border the creeks and fields, but the landscape generally has a highly artificial and denuded aspect. The altitude is 3,480 feet, but owing to the dryness at this particular point, the climate is cooler than usual at so low an elevation, corresponding to that of San Miguel Bridge, which has an altitude almost twice as great. The manager of the



hacienda, Don Carlos Duque, informed me that as late as twenty years ago several species of large currasows, guans, parrots, tinamous, and other tropical birds, were to be found in the scrubby or bush country in the vicinity, but that constant shooting by villagers had exterminated them. (Pl. 9.)

Heller Expedition, October 25, 1915; Chapman Expedition, July 11-14, 1916; 116 specimens of 37 species.

Idma (altitude 5,000 feet, Subtropical Zone).—The hacienda of Idma, some 9 miles southwest of Santa Ana and 1,500 feet above it is in the humid subtropics. Traces of forest first appear at an elevation of 4,200 feet, but the floor of the valley has long been deforested and is largely devoted to the growing of sugar cane. The steeply ascending mountains are heavily wooded from the valley to their summits, and a short distance above the hacienda, where our camp was made, the country is everywhere forested. The fauna is typically subtropical and closely resembles that of the Urubamba Canyon above San Miguel Bridge. Kalinowski collected at Idma chiefly in July, August, October, and November, 1894, securing representatives of 75 species.¹³

Mr. Heller's notes on Idma follow:

Idma is without doubt one of the rainiest places in all Peru. There is scarcely a day throughout the whole year in which some rain does not fall at this spot. Such conditions, however, are very local and due largely to the high forested ranges which overhang the hacienda of Idma. A league or two lower down the valley, toward Santa Ana, the sun holds sway half of the year at least part of each day. The unfortunate inhabitants of Idma have daily vistas of sunshine lower down the valley through the very raindrops that give this place its distinction. The altitude at the hacienda is 5,000 feet. The temperature is seldom disagreeably warm in the day-time and at night it is comfortably cool so the climate, barring its wetness, may be described as delightfully semitropical.

Originally the slopes and floor of the valley were occupied by a heavy forest which was removed centuries ago by the Incas. Within a stone's throw of the cultivated fields above the hacienda the dark primeval forest sweeps down from the range above and beyond. Idma is a cultivated nook of valley projecting into the great forest and maintained only by constant strife with the forces of nature.

Heller Expedition, October 10-23, 1915; Chapman Expedition, July 11-14, 1916; 239 specimens of 72 species.

Rio San Miguel (altitude 4,400 feet, humid Tropical Zone).—One of Heller's collecting stations at the upper margin of the humid Tropical Zone. It is described by him as follows:

Our introduction to the lowland forest of the Amazon basin took place at San Fernando, which is situated on the upper borders in the hill country at the foot of the Andean cordillera. The geographical position of this spot is some ten leagues northwest of the village of Lucma from which it is separated by a high, cold spur of the Andes in which the headwaters of the Rio Cosireni take their rise. San Fernando is situated well down in the drainage area of this river at 4,400 feet altitude in the valley of a tributary stream, the Rio San Miguel, a few miles above its junction with the Rio Pampaconas. The spot to which the name San Fernando is attached is marked by a single hut in the neighborhood of which sugar cane, cassava, coffee, ground nuts, pine-

¹⁸ Ornis, 1913, pp. 73-102.

apples, bananas, and a few other tropical fruits are grown by the Mestizo family which make this place their home. At this point the valley of the San Miguel is wide, level, and densely forested.

The climate has the delightful balmy qualities of that of San Miguel Bridge and Huadquiña, combined with a somewhat greater degree of heat and much more humidity. On bright days the weather is really hot but the sky as a rule is overcast part of each day. During our visit in October, rain fell almost every night for a few hours, usually in the form of a thunder shower.

The tree growth fills the whole valley from the floor to the summits of the confining ridges. The forest is of a mixed character, the number of tree species being large, but the different species are everywhere scattered so universally that there is really no marked uniformity in the general appearance of the woodland. I recognized in this forest several species of trumpet trees, figs, tree ferns, small palms, cedros, etc. Traveling, as a rule, was not difficult through the forest, except near streams where the trees were bound together by giant vines and creepers.

The chief avenue of exploration in this region, however, was the road cut by the rubber gatherers for the transport of the rubber from Yuvini to Lucma, and then to Cuzco. This road was cut some 20 yards in width through the forest and followed the level floor of the valley wherever practical. Travel along this wide rock-free thoroughfare was a never-ending source of delight after the months of hardships and conflict with the rock-strewn trails of the higher Andes.

Heller Expedition, September 29-October 6, 1915; 33 specimens of 31 species.

Yuvini, near Rio Cosireni (altitude 3,000 feet, humid Tropical Zone).—The Rio Cosireni enters the Urubamba from the southwest some 65 miles in an air-line north by west from Santa Ana. This was one of Heller's two stations in the humid Tropical Zone. Specimens from it are listed under "Rio Cosireni." Heller writes:

Journeying from the village of Lucma northward over the high ridges which bound the Vilcabamba Valley, we drop down at the end of a day's travel into the watershed of the Cosireni River. Following down one of the head streams, the San Miguel, we come to its junction with the Pampaconas River, from which point the Cosireni proper has its origin through the united waters of these two large affluents. Some 6 leagues beyond, farther down the Cosireni, we come to the rubber station of Yuvini, established and managed by a Dane, Alvin Berg. The thatched huts of the station stand on a plateau a few hundred feet above the river, and well back from its margin, for the valley here has a width of a league or more. Flowing past the station and supplying it with water, is a small stream, the Yuvini, which meanders on to its union with the Cosireni 2 miles beyond.

The geographical position of Yuvini is 10 leagues north of Lucma, or more correctly west of north of that place, but by the road it is some 20 leagues, or 3 days' travel by pack train. Yuvini has an altitude of 3,000 feet. At this elevation, the climate is tropical and humid, but the heat here has seldom the oppressive quality which is encountered 1,500 feet lower down the valley.

During our 3 weeks' sojourn here in August and early September, part of each day was overcast by rain squalls and thunder showers of short duration. The air at midday was heavy with moisture, and rain fell at frequent short intervals interspersed by bright intense sunshine. Berg, who had been a resident for 15 years, informed me that this was the usual sort of weather, and that even during the height of the rainy season, some months later, there was seldom a day without some sunshine.

When we arrived in mid-August, the river was clear and low but frequently it became a dark brown flood, and rose rapidly in volume owing to heavy rains in its upper watershed. The suddenness of the rise of such floods and their short duration

spoke eloquently of the brevity of the watershed. June and July are said to be the really dry months, when continuous sunshine is the rule. At midday the heat is often intense, but the nights are seldom uncomfortable or hot. Malaria is rare at this particular spot, but this is owing to the absence of mosquitoes, due to the good drainage of the land. From Yuvini you look out upon a wide valley bounded at some distance by gently rounded hills, the whole landscape forest covered without a cliff or rock showing.

Heller Expedition, September 7-13; 18-20; 28, 1915; 46 specimens of 33 species.

Rio Comberciato (altitude 1,800-2,000 feet, humid Tropical Zone).— The Rio Comberciato enters the Urubamba from the northwest some 70 miles west by north of Santa Ana. This was the second of Heller's two stations in the humid Tropical Zone. The collections from this point and the Rio Cosireni (the second tropical station) represent only a small portion of the existing fauna, but are sufficient to show the zonal affinities of the region. Mr. Heller's notes follow:

Parallelling the Cosireni River in a general way, but lying a few leagues farther north is the Comberciato River which enters the Urubamba at its great bend. The Comberciato has twice the volume of the Cosireni and is much less rapid. The valley through which this stream flows is much deeper and narrower, however, than that of its neighbor, but the river is a series of broad, quiet expanses separated by low, short rapids free of projecting bowlders. The forest covers the whole landscape without any interruptions due to barren rock surfaces or other causes. The hillsides are soil covered like the valley floor.

The lower course of the river where the Yuvini road drops down into the valley, has an altitude of 1,800 feet and this level is maintained for several leagues as we ascend the river. Our highest point on the river was a station called Arroyo at which point a wire cable has been erected by the rubber gatherers for passing their cargoes of rubber. This point is about 4 leagues up the river at the termination of the road and has an altitude of 2,000 feet. Climatically the valley is much warmer than the Yuvini District, owing to its lesser elevation.

At nights there is a continuation of the heat, but little less than in the shade at midday. The river playas or beaches are extensive and wide, the older ones being covered by a growth of tall, spiny bamboo and the newer beaches by glistening white pebbles. A few species of trees occur here which are not found at Yuvini, but the country in general is quite identical to the Cosireni Valley.

Heller Expedition, September 4-6; 13-15; 21-25, 1915.

LIFE ZONES OF THE URUBAMBA VALLEY.

My reconnaissance in the Urubamba Valley and subsequent study of our collections from it have had for their object the determination of the life zones of this section of the Andes and comparison of them with those which we have found to exist in Colombia.

Field experience in the last-named country enabled me to make this comparison in part in the field, while Heller's excellent descriptions of the district visited by him, which I saw only at a distance or did not reach at all, in connection with fairly representative collections, permit me to present at least a provisional report on the subject under consideration. In general it may be said that the Tropical, Subtropical, and Temperate Zones of the Urubamba district are essentially the Tropical, Subtropical, and Temperate Zones of Colombia; the same altitudinal boundaries and many of the same species being common to both regions. When, however, we compare the Paramo or Puna Zone of the two countries the area occupied by this zone in Peru is so much larger and its distance from the region whence its fauna was presumably derived is so much shorter, that there is a marked difference in the character of its fauna as will be shown beyond.

TROPICAL ZONE.

The Tropical Zone is represented in the Urubamba Valley in both its humid and arid phases. The former, characterized by heavy rainfall and consequently luxuriant forest growth, ascends the valley to the vicinity of Echarati, some 30 miles below Santa Ana. The latter, distinguished by lower rainfall and a xerophytic vegetation of which acacias and cacti are prevailing types, extends up the floor of the valley to about San Miguel Bridge (altitude 6,000 feet), or the lower border of the forests of the Subtropical Zone.

Our stations in the humid Tropical Zone were Rio Cosireni (altitude 3,000 feet) and Rio Comberciato (altitude 1,800-2,000 feet). These were visited only by Heller who secured, as elsewhere mentioned, 74 specimens of 58 species of which 42, not found elsewhere, are characteristic of the humid tropics. This number includes such typical tropical forms as Tinamus major ruficeps, Crypturus soui, Penclope jaquaçu, Eurypyga major meridionalis, Capito auratus insperatus, Monasa morphoeus peruana, Cephalopterus ornatus, Ostinops decumanus maculosus, etc. While the number of species secured obviously represents only a small part of the existing avifauna, it is sufficient to determine its faunal attributes.

It may also be remarked in passing that this small collection illustrates the uniformity of Tropical Zone life where essentially similar conditions exist, all of the genera and 30 of the 42 characteristic species it contains being found in Colombia.

Our only station in the arid Tropical Zone was Santa Ana, where the hospitality of Senor Duque, rather than the attractions of the fauna, evidently induced Kalinowski as well as the representatives of the Yale University-National Geographic Society to make their headquarters. The Santa Ana Valley is a typical arid pocket such as is found in many places in the Tropical Zone. Though completely isolated from one another, often by wide areas of the humid Tropical Zone, certain species are common to them all, and, as a rule, slight differentiation from type is exhibited. Several subspecies have been described from the Santa Ana Valley, though I do not know that they are restricted to it, but only one species (Thamnophilus melanochrous) appears to be peculiar to this district.

The statement of Carlos Duque, quoted by Heller, shows that the settlement of the Santa Ana Valley has been followed by the disappearance of certain species hunted for their flesh, but it is not probable that any very marked change in the fauna has occurred. The rainfall is too small to have produced a forest and crops are grown successfully only under irrigation.

The 66 species recorded from the Santa Ana Valley probably, therefore, fairly represent the original fauna. Of this number, 38, or more than half, are of general distribution throughout Tropical Of the remaining 28, no less than 19 are of Brazilian origin. Some of these birds, as Nothura maculosa, Bucco chacuru, and Euscarthmus margaritaceiventer, extend southward to Paraguay and are unknown north of the Amazon, while eight of them range eastward and northward to Guiana. These are: Hoploxypterus cayanus, Ciccaba huhula, Eupetomena macroura hirundo (subspecies Peruvian), Elaenia cristata, Sublegatus fasciatus, Myiarchus pelzelni, Alopochelidon fucata, Coryphospingus cucullatus. None of these, it is interesting to note, has been recorded from Colombia. There are also several species like Elaenia gigas, Sporophila obscura and Piranga testacea which do not range far from the base of the Andes, but the distinctive avifauna of the arid Tropical Zone of the Santa Ana Valley has evidently been derived through western Brazil and it contains both southern and northern elements.

DISTRIBUTIONAL ANALYSIS OF ARID TROPICAL ZONE BIRDS.

Crypturus purvirostrisSoutheastern and central Brazil.	
Nothura maculosa peruviana Southern Brazil to Uruguay; subspecies Peru	ı.
Columba rufina rufina	
Zenaida auriculata pallens Southern South America; subspecies Pacif	fic
coast to Colombia.	
Chamaepelia minuta minutaTropical South America.	
Leptotila ochroptera ochropteraSouthern and eastern Brazil.	
Creciscus viridis facialis	
Hoploxypterus cayanus Southern Brazil to Guiana.	
Helodromas solitariusNorth American migrant.	
Phalacrocorax vigua viguaSouth America generally.	
Cathartes atrataSouth America generally.	
Catharista urubuSouth America generally.	
Parabuteo unicinctus unicinctusSouth America generally.	
Cerchneis sparveria, subspeciesSouth America generally.	
Otus cholibaSouth America generally.	
Ciccaba huhulaBrazil to Guiana.	
Tyto perlata, subspeciesSouth America generally.	
Ceryle americana	
Streptoprocne z. zonarisSouth America generally.	
Eupetomena macroura hirundo Brazil to Guiana; subspecies Peru; Bolivia.	
Chlorostilbon prasinus daphneTropical South America; subspecies Peru	to
Colombia.	
Piaya cayana obscuraTropical America; subspecies Peru, Bolivia	2,

western Brazil.

Tapera naeviaTropical South America.
Crotophaga aniTropical America.
Bucco chacuruBrazil to Paraguay.
Ceophloeus lineatusTropical South America.
Veniliornis haematostigma hilarisBolivia, western Brazil; subspecies Peru.
Thamnophilus melanochrous
Thamnophilus radiatus subradiatus Tropical South America; subspecies Peru,
western Brazil.
Dysithamnus olivaceusTropical South America.
Microrhopias rufa rufater
Cercomacra tyrannina approximansTropical America; subspecies Peru, Ecuador,
Bolivia, central Brazil.
Synallaxis hypospodiaTo Bahia, Brazil.
Muscisaxicola fluviatilisPeru to Colombia.
Todirostrum cinereum cinereumTropical America.
Euscarthmus margaritaceiventer rusipes. Central Brazil to Paraguay; subspecies Peru.
Myiosympotes acutipennisColombia to Bolivia.
Elaenia flavogasterTropical America.
Elaenia gigasColombia to Peru.
Elaenia cristataBrazil to Guiana and Venezuela, Ecuador,
Bolivia, central Brazil.
Myiopagis viridicataTropical South America.
Sublegatus f. fasciatusArgentina to Guiana.
Myiozetetes cayennensisTropical South America.
Myrobius fasciatus saturatus Tropical South America; subspecies Peru.
Empidonax trailli alnorumNorth American migrant.
Myjarchus tyrannulus chlorepiscius Tropical South America; subspecies Peru to
Argentina.
Myiarchus pelzelniBrazil to Guiana.
Tyrannus m. melancholicusSouth America generally.
Tyrannus m. melancholicusSouth America generally. Stelgidopteryx r. ruficollisTropical South America; subspecies eastern
Stelgidopteryx r. ruficollisTropical South America; subspecies eastern Colombia to Paraguay.
Stelgidopteryz r. ruficollisTropical South America; subspecies eastern
Stelgidopteryx r. ruficollis
Stelgidopteryx r. ruficollis. Tropical South America; subspecies eastern Colombia to Paraguay. Alopochelidon fucata. Argentina to Guiana. Troglodytes musculus audax South America generally; subspecies Peru. Vireosylva c. chivi. Tropical South America. Compsothlypis pitiayumi elegans Tropical America; subspecies Peru to Venezuela. Geothlypis aequinoctialis cucullata Brazil to Argentina. Sporophila gutturalis inconspicua Tropical South America; subspecies Peru. Sporophila obscura Ecuador to northern Argentina. Volatinia jacarini jacarini Tropical America; subspecies Peru, Bolivia; Brazil. Myospiza aurifrons peruana Colombia, Peru, western Brazil; subspecies Peru. Coryphospingus cucullatus Paraguay to Guiana. Tanagra laniirostris peruviana Western Brazil, Bolivia; subspecies Peru. Thraupis episcopus major Tropical South America; subspecies Peru. Thraupis palmarum melanoptera Western Tropical America. Ramphocelus carbo connectens Tropical South America; subspecies Peru, western Brazil. Piranga testacea tschuth Central America, western South America; subspecies Peru,
Stelgidopteryx r. ruficollis. Tropical South America; subspecies eastern Colombia to Paraguay. Alopochelidon fucata Argentina to Guiana. Troglodytes musculus audax South America generally; subspecies Peru. Vireosylva c. chivi Tropical South America. Compsothlypis pitiayumi elegans Tropical America; subspecies Peru to Venezuela. Geothlypis aequinoctialis cucullata Brazil to Argentina. Sporophila gutturalis inconspicua Tropical South America; subspecies Peru. Sporophila obscura Ecuador to northern Argentina. Volatinia jacarini jacarini Tropical America; subspecies Peru, Bolivia; Brazil. Myospiza aurifrons peruana Colombia, Peru, western Brazil; subspecies Peru. Coryphospingus cucullatus Paraguay to Guiana. Tanagra laniirostris peruviana Western Brazil, Bolivia; subspecies Peru. Thraupis episcopus major Tropical South America; subspecies Peru. Thraupis palmarum melanoptera Western Tropical America. Ramphocelus carbo connectens Tropical South America; subspecies Peru, western Brazil. Piranga testacea tschuth Central America, western South America; subspecies Peru. Tachyphonus rufus Tropical America.
Stelgidopteryx r. ruficollis. Tropical South America; subspecies eastern Colombia to Paraguay. Alopochelidon fucata. Argentina to Guiana. Troglodytes musculus audax South America generally; subspecies Peru. Vireosylva c. chivi. Tropical South America. Compsothlypis pitiayumi elegans Tropical America; subspecies Peru to Venezuela. Geothlypis aequinoctialis cucullata Brazil to Argentina. Sporophila gutturalis inconspicua Tropical South America; subspecies Peru. Sporophila obscura Ecuador to northern Argentina. Volatinia jacarini jacarini Tropical America; subspecies Peru, Bolivia; Brazil. Myospiza aurifrons peruana Colombia, Peru, western Brazil; subspecies Peru. Coryphospingus cucullatus Paraguay to Guiana. Tanagra laniirostris peruviana Western Brazil, Bolivia; subspecies Peru. Thraupis episcopus major Tropical South America; subspecies Peru. Thraupis palmarum melanoptera Western Tropical America. Ramphocelus carbo connectens Tropical South America; subspecies Peru, western Brazil. Piranga testacea tschuth Central America, western South America; subspecies Peru,

SUBTROPICAL ZONE.

The remarkable stratum of life which lies approximately between the elevations of 5,000 and 9,000 feet on the eastern slope of the Andes and extends from Bolivia to Venezuela makes a fold or loop up the Urubamba Valley. In the lower valley its inferior limits merge with the upper border of the humid Tropical Zone in one unbroken sweep of forest; at Santa Ana they are coextensive with the cloud belt below which grassy, treeless slopes reach to the floor of the tropical valley, while from a short distance above San Miguel Bridge (altitude 6,000 feet), at the foot of Machu Picchu, almost to Torontoy, the forests of the Subtropical Zone reach the shores of the river, whence, in places, they extend upward to merge with those of the humid Temperate Zone.

Above Santa Ana the Subtropical Zone is first encountered on the western side of the valley at Idma, and from this point forest extends into the Temperate Zone.

Birds have been collected in the Subtropical Zone of the Urubamba Valley only at Idma and in the Machu Picchu district. From these localities 105 species have been secured which may be considered as zonally representative. Comparison of the results of our work with those of Kalinowski's indicates that this number fairly represents the fauna. It does not, however, fairly represent the fauna of the Subtropical Zone of Peru, since in Colombia we obtained 230 species which were distinctively subtropical. The data at hand, therefore, do not warrant a comparison of the bird life of the Subtropical Zone in Peru and Colombia, but they do show the remarkable uniformity of the life of that zone, a fact to which I have previously called attention.12 Thus, of 77 genera secured by us in the Subtropical Zone of the Urubamba Valley, no less than 74 also occur in this zone in Colombia; the genera Knipolegus, Phylloscartes, and Thlypopsis being the only ones absent from Colombia. Of the 104 Urubamba species contained in these genera, 57 are common both to Peru and Colombia.

TEMPERATE ZONE.

The Temperate Zone has both a humid and an arid section. The former is found on the more easterly ranges of the Andes, on which are condensed the moisture-bearing winds from the Atlantic. Here well-developed forest reaches an average altitude of 12,500 feet. Above this altitude lies the Puna. The line between the two may be abrupt or the two may merge by an upward extension of bushygrown areas, the latter forming the arid portion of the Temperate Zone. Heller writes that the forest at Cedrobamba (altitude 12,500 feet) "stops as abruptly as if cut by a knife" and is succeeded by the grassland of the Puna.

¹⁹ Bull. Amer. Mus. Nat. Hist., vol. 36, 1917, p. 135.

At other localities, notably inner valleys with comparatively low rainfall, the Temperate Zone is characterized by a scrubby vegetation restricted largely to the borders of streams, up which the arid portion of the zone extends finger-like projections well into the Puna Zone.

Conditions of this kind can be understood only by one who has observed them in the field. They can not be expressed by the most careful labeling of specimens. A collection from Ttica-Ttica (altitude 11,900 feet), for example, contains a mixture of forms apparently not susceptible of zonal interpretation. With such characteristic species of the Puna as Upucerthia pallida, Geositta tenuirostris, Agriornis solitaria insolens, Muscisaxicola rufivertex, etc., there are presumably associated Anaeretes flavirostris, Serpophaga cinerea, Elaenia albiceps, Saltator albociliaris, Diglossa brunneiventris, etc., but in the field it was found that the first group was largely restricted to the grassy slopes, while the second was found only in the narrow fringe of bushes at the borders of streams.

The collection from Cedrobamba contains a similarly confusing assemblage of Temperate and Puna Zone forms, the occurrence of which within a restricted area is explained by Heller's description of the striking conditions which exist at that locality. The upper limit of the Temperate Zone, therefore, coincides with the upper limit of tree or bush growth, and this may often be at a higher altitude than the lower limit of the succeeding or Puna Zone.

On the eastern slopes of the Andes the lower limits of the Temperate Zone correspond with the upper limits of the Subtropical Zone, and although forest may stretch continuously from timberline to the Amazonian plains, the limit between the two zones is here uniformly about 9,000 feet. Where, however, lack of rain prevents the development of the forest which so strongly distinguishes the Subtropical Zone, the Temperate Zone in its arid phase may descend much lower. In the Urubamba Valley it reaches Torontoy at 8,000 feet and on the treeless Pacific slope of the Andes it actually descends to sea level. The influence exerted by the Humboldt current must, however, be taken into consideration here, an inquiry which would lead us far beyond the scope of this paper.

The assemblage of species characterizing the Temperate Zone is intensely interesting. Being either tree or bush inhabiting, it is clear that they must have had their geographic origin in tree or bushgrown regions. The humid South Temperate Zone is separated from the district under consideration by 1,500 miles of treeless country, which has proved an effective barrier to the northward extension of the forest-inhabiting species of southern Chile.¹⁴

¹⁴ Scytalopus is an exception; but it is not improbable that Scytalopus originated in the mountains of southeastern Brazil where its present isolation from the Andean forms is paralleled among trees by Arau earls.



It seems evident, therefore, that the avifauna of the Temperate Zone can have originated only in the forested regions lying below it, and in its parrots, humming birds, toucans, trogons, flycatchers, tanagers, and honey creepers it is evident that we have the highly differentiated descendants of tropical forms.

The area occupied by the Temperate Zone is by no means so large as that of the Subtropical Zone and the number of species inhabiting it is correspondingly small. But analysis shows that the bird life of the Temperate Zone is more distinct than that of any other zone.

Of the species known from the Urubamba region 70 may be accredited to the Temperate Zone. Of these, seven are wide-ranging species not zonally characteristic. Examples are Falco fusco-cærulescens, Tyto perlata, Serpophaga cinerea. The remaining 63 species represent 44 genera of which 4 genera are of general distribution, 8 Tropical, 1 Andean and southeast Brazil, 1 Andean Temperate and South Temperate, 2 Subtropical and Temperate, while 28 of these genera, or nearly two-thirds the total number, are restricted to the Andean Temperate Zone.

Of the 63 characteristic species which we collected, no less than 56 are Andean Temperate, 7 are Subtropical and Temperate, while 6 of the latter are represented in the Temperate Zone by subspecies which are peculiar to it.

This remarkable degree of specialization becomes even more noteworthy when the avifauna of the Temperate Zone is compared with that of the Puna Zone. Comment on it may, therefore, be preceded by consideration of Puna Zone bird life.

DISTRIBUTIONAL ANALYSIS OF TEMPERATE ZONE BIRDS.

Columba albipennis	Genus cosmopolitan; species Temperate Zone.
Columba albilinea	Genus cosmopolitan; species Subtropical and
	Temperate Zones.
Merganetta leucogenys	Temperate Zone, genus and species.
Aratinga mitrata alticola	Genus Tropical; subspecies Temperate.
Amoropsittaea andicola	Genus Tropical; species Temperate.
Thermochalcis ruficervix	Genus Tropical; species Temperate.
	Genus cosmopolitan; species Temperate.
	Genus cosmopolitan; species Subtropical and
-	Temperate Zones.
Aglaeactis castelnaudi	Genus and species Temperate Zone.
Heliangelus amethysticollis	Genus and species Temperate Zone.
Metallura s. smaragdinicollis	Genus and species Temperate Zone.
Oreonympha nobilis	Genus and species Temperate Zone.
Chalcostigma stanleyi vulcani	Genus and species Temperate Zone.
Chalcostigma olivaceum	Genus and species Temperate Zone.
Psalidoprymna nuna	Genus and species Temperate Zone.
Scytalopus acutirostris	Genus Andean, southeast Brazil; species Tem-
-	perate Zone.

	enus Andean, southeast Brazil; species Temperate Zone.
	enus Tropical; species Temperate Zone.
Hyloperus rufula obscuraG	enus and species Temperate Zone.
Schizoeaca palpebralisG	enus and species Temperate Zone.
Varaararnis nerlata	enus Subtropical and Temperate; species
•	Temperate Zone.
Ochthoeca fumicolor berlepschiG	enus and species Temperate Zone.
Ochthoeca leucophrys leucometopaG	enus and species Temperate Zone.
Ochthoeca frontalis spodionotaG	enus and species Temperate Zone.
Ochthoeca lessoni tectricialisG	enus and species Temperate Zone.
Ochthoeca thoracicaG	enus and species Temperate Zone.
Mecocerculus leucophrys setophagoides G	enus and species Temperate Zone.
Mecocerculus stictopterus taeniopterusG	enus and species Temperate Zone.
Caenotriccus ruficeps	enus Temperate and South Temperate;
Andereies Ramfoetris	species Andean.
Anometro amendia	enus Temperate and South Temperate;
	species Andean.
Elaenia albiceps, subspeciesG	enus Tropical; subspecies Temperate Zone.
Heliochera rubrocristataG	enus and species Temperate Zone.
-	enus Western Hemisphere; subspecies Andean Temperate Zone.
Troglodytes solstitialis macrourusG	enus Western Hemisphere; subspecies Andean Temperate Zone.
Semimerula gigas gigantodesG	enus and species Temperate Zone.
Semimerula chiquancoG	enus and species Temperate Zone.
Basileuterus luteoviridis su perciliarisG	enus Tropical; subspecies Temperate Zone.
Catamenia i. inornalaG	enus and species Temperate Zone.
Catamenia analoides griseiventrisG	enus and species Temperate Zone.
Spinus ictericus peruvianusG	enus cosmopolitan; subspecies Temperste Zone.
Poospizopsis caesarG	enus and species Temperate Zone.
Atlapetes canigenisG	enus Subtropical and Temperate; species
•	Temperate Zone.
Diglossa brunneiventrisG	enus and species Temperate Zone.
Diglossa mystacalis albilineaG	enus and species Temperate Zone
Diglossa personata melanopisG	enus and species Temperate Zone.
Oreomanes fraseriG	enus and species Temperate Zone.
Conirostrum cyaneumG	enus and species Temperate Zone
Controstrum ferrugineiventris	enus and species Temperate Zone.
Comirostrum c. einereumG	enus and species Temperate Zone.
Xenodacnis parinaG	enus and species Temperate Zone.
Iridosornis j. jelskiiG	enus and species Temperate Zone.
Poecilothraupis igniventrisG	enus and species Temperate Zone
Buthraupis cucullata saturataG	enus and species Temperate Zone
Dubusia stictocephalaG	enus Tropical; subspecies Temperate Zone.
Hemispingus atropileus auricularisG	anus and species Temperate Zone.
Hemispingus superciliaris nigrifronsG	enus and species Temperate Zone.
Pseudospingus zanthophthalmusG	enns and species Temperate Zene.
Microspingus trifasciatusG	enus and species Temperate Zone.
Cyanolyca jolyaeaG	enus and species Temperate Zone.
Cyanolyca viridicyanea cuzcoensisG	enus and species Temperate Zone.
2787—21——3	- · · · · · · ·

summary of distributional analysis of 51 genera and 70 species taken in the temperate zone.

GENERA.

Of general distribution	11
Of South Temperate Zone origin	1
Andean and southeastern Brazil	1
Tropical	8
Restricted to Subtropical and Temperate Zones	2
Restricted to the Temperate Zone	28
Total	51
SPECIES.	
Of general distribution	7
Restricted to the Subtropical and Temperate Zones	
Restricted to the Temperate Zone	56
Total	70

PUNA OR PARAMO ZONE.

The Puna of Peru corresponds to the Paramo of Colombia. Both regions lie between the upper limit of arborescent vegetation and the lower limit of snow. On the eastern Andes in the Urubamba region, this is approximately between the altitudes of 12,500 and 15,000 feet,¹⁶ limits which agree with those we found to exist in the Central Andes of Colombia.

Faunally, however, where insufficient rainfall prohibits forest growth, the Puna Zone reaches a much lower level. As stated previously, at Ttica-Ttica (altitude 11,900 feet), near Cuzco, it completely inosculates with the upper border of the arid Temperate Zone. The two zones are here distinguished by the presence or absence of bushy vegetation, a difference controlled wholly by water supply. Much additional field work is required to determine the interrelations of these zones. Since the bird life of the Puna has been derived largely from the South Temperate Zone in Patagonia it may prove to be desirable to characterize the Puna as an Andean Temperate and apply a new name for the forested and bushgrown Zone which I have here termed Temperate. This problem, however, can not be treated from a local standpoint, nor indeed do data as yet exist for its solution.

In Colombia the flora of the Paramo with its frailejons and other striking species, is so characteristic that no difficulty is experienced in distinguishing Temperate Zone savanna from the Paramo above it. But the uniformly grass-covered plains and slopes and the marshes of the Puna afford no such obvious boundaries.

In Colombia we found some 70 genera and somewhat over 100 species characteristic of the Temperate Zone. I can not say whether the excess in number over those found in Peru is actual or due to an incomplete knowledge of Peruvian bird life, but note that even our local collecting in the Urubamba Region reveals the much more highly developed Puna or Paramo fauna of Peru.

¹⁶ See Bowman, the Andes of southern Peru, p. 274.

No doubt, however, can exist as to the origin of the Puna avifauna. Suited only for the needs of plain, marsh, and water-inhabiting species, Puna bird life has been largely derived from the vast area of plains, marsh, and lakes which, without topographic barrier, bounds it on the south and extends nearly to the southern limits of the continent.

The South Temperate Zone ducks and grebes find a suitable home on the Puna lakes, where they are represented by permanently resident races, while the oven-birds (Furnariidae) and finches of Patagonia find congenial haunts and climatic conditions on the high Andean table-land.¹⁷

Subtracting from the 58 genera found by us on the Puna, 27 of general distribution (as Spatula, Phalacrocorax, Falco, Anthus, etc.), and we have left 31 genera, of which 19 are of the South Temperate Zone, while only 7 are peculiar to the Puna. Compare these figures with those given for the Temperate Zone and it is seen that the latter owes practically nothing to the South Temperate Zone, while it has a far larger proportion of endemic genera. Thus, of the genera found by us in the Puna Zone, slightly more, than 7 per cent are endemic, while of those found in the Temperate Zone 55 per cent are endemic.

Continuing the comparison with the species found in the two zones, it is seen that somewhat more than 57 per cent of Puna Zone species are endemic, while of Temperate Zone species 80 per cent are endemic.

The most obvious reason for the much greater differentiation of the life of the Temperate Zone as compared with that of the Puna Zone is apparently to be found in the geographic origin of their respective faunas. That of the Temperate Zone, as we have seen, presumably originated in the Tropical Zone, that of the Puna in the South Temperate Zone. The former has consequently been subjected to the influences of the wide climatic differences lying between the Tropical and Temperate Zones, the latter has found in the Puna Zone a climate not radically different from that in which we assume it originated.

It is probable that the life of the Temperate Zone, having doubtless passed through a Subtropical Zone stage, is older than that of the Puna. This, however, is one of the many problems connected with the origin of Andean life which we are not as yet in a position to attack. I restrict myself therefore to the comparison which clearly reveals the great distinctness of Temperate Zone bird life, and repeat my belief that this distinctness is not primarily dependent upon the age of the fauna, but mainly to the influence of the marked climatic differences existing between the Tropical and Temperate Zones.

If the entire known avifauna of Peru were here under review due consideration would of course begiven the Limicolae, Flamingoes, Rhess, and other Puna birds of which we secured no specimens.





Fig. 2.—Semi-diagrammatic representation of the range of heliochera, a very distinct companie genus restricted to the forests of the humid temperate some, which has presumably been derived from a forest-inhabiting ancestor of the humid tropical zone at the base of the andes. The humid temperate some forest, and hence the distribution of the genus, is doubtless less continuous than is here indicated.



FIG. 3.—SEMI-DIAGRAMMATIC REPRESENTATION OF THE RANGE OF UPUCERTHIA, A GENUS OF THE TREE-LESS SOUTH TEMPERATE ZONE, WHICH HAS EXTENDED ITS RANGE FROM PATAGONIA TO COLOMBIA OVER THE TREELESS PUNA OF PARAMO ZONE OF THE ANDES. COMPARE WITH MAP SHOWING RANGE OF THE GENUS HELECCHERA, WHERE THE MARKED ENVIRONMENTAL DIFFERENCES SETWEEN TROFICAL AND TEMPERATE FORESTS, SEPARATED BY BUT FEW MILES, ARE BELIEVED TO HAVE RESULTED IN THE DEVEL-OPMENT OF THE DISTINCT TYPES CHARACTERIZING THE HUMID TEMPERATE ZONE, WHILE SPECIES OF THE PATAGONIAN PLAINS RANGE 4,000 MILES NORTHWARD OVER HIGH ANDEAN PLAINS WITH ONLY SLIGHT DIFFERENTIATION.

DISTRIBUTIONAL ANALYSIS OF PUNA SOME BIRDS.

No. 1 A. 1
Nothoprocta fulvescens
Nothoprocta kalinowskii
Nothura maculosa bolivianaGenus and species South Temperate; subspecies Puna Zone.
Gymnopelia c. ceciliaeGenus and species Puna; Peru to Argentina.
Metriopelia m. melanopteraGenus and species Puna; Ecuador to Argentina.
Pardrallus r. rytirhynchusGenus and species South Temperate.
Gallinula galeata garmaniGenus cosmopolitan; subspecies Puna Zone.
Fulica arderiaca
Fulica giganteaGenus cosmopolitan; species Puna Zone.
Podiceps callipareus juninensisGenus cosmopolitan; species South Temperate;
subspecies Puna Zone.
Podiceps americanus
subspecies Puna Zone.
Larus serranusGenus cosmopolitan; species Puna Zone.
Thinocorus orbignyanusGenus and species South Temperate.
Ptiloscelys resplendensGenus and species Puna Zone, Ecuador to
Argentina.
Gallinago braziliensis andinaGenus cosmopolitan; species Brazil and Argen-
tina; subspecies Puna Zone.
Theristicus branickii
Plegadis ridgwayiGenus cosmopolitan; species Puna Zone.
Nycticorax n. tayaxu-guiraGenus cosmopolitan; subspecies South Ameri-
Can.
Nycticorax cyanocephalusGenus cosmopolitan; species Chilean.
Chloephaga melanopteraGenus and species South Temperate.
Anas cristata alticola
subspecies Puna Zone.
Nettion oxypterumGenus cosmopolitan; species Puna Zone.
Dafila spinicaudaGenus cosmopolitan; species South Temperate Zone.
Querquedula punaGenus cosmopolitan; species Puna Zone.
Querquedula cyanoptera orinomusGenus cosmopolitan; species Western Hemi-
sphere; subspecies Puna Zone.
Spatula plataleaGenus cosmopolitan; species South Temperate
Zone.
Oxyura ferrugineaGenus Western Hemisphere; species Puna Zone.
Phalacrocorax v. vigua
Sarcorhamphus gryphusGenus and species South Temperate Zone.
Ibycter megalopterusGenus South Temperate; species Puna Zone.
Circus cinereusGenus cosmopolitan; species South Temperate
Zone.
Buteo erythronotusGenus cosmopolitan; species South Temperate
Zone.
Buteo poecilochrousGenus cosmopolitan; species Puna Zone.
Spiziastur melanoleucusGenus and species South America.
Falco fusco-caerulescens
Cerchneis sparveria, subspeciesGenus Western Hemisphere; species American.
Spectyto cunicularia juninensisGenus and species Western Hemisphere; sub-
species Puna Zone.
Pterophanes cyanopterusGenus and species Puna Zone.
Vestipedes sapphiropygiaGenus Temperate and Puna; species Puna Zone. Metallura aeneocaudaGenus Temperate and Puna; species Puna Zone.
messassas acreeomata trenus 1emperate and runa; species runa zone.

Patagona gigasGenus and species Puna Zone; South Tem-
perate Zone in Chile.
Oreotrockilus estellaGenus and species Puna Zone.
Colaptes punaGenus Western Hemisphere; species Puna Zone.
Geositta tenuirostris
Upucerthia pallidaGenus South Temperate; species Puna Zone.
Cinclodes fuscus rivularisGenus and species South Temperate; subspe-
cies Puna Zone.
Cinclodes atacamensis
Leptasthenura andicola peruvianaGenus South Temperate; species Puna Zone.
Leptasthenura pileataGenus South Temperate; species Puna Zone.
Siptornis albicapillaGenus South Temperate; species Puna Zone.
Siptornis modesta proximaGenus South Temperate; species Puna Zone.
Siptornis ottonis
Siptornis graminicolaGenus South Temperate; species Puna Zone.
Siptornis urubambensisGenus South Temperate; species Puna Zone.
Phacellodomus striaticeps griscipectus. Genus North Argentina; species Puna Zone.
Agriornis pollensGenus South Temperate; species Puna Zone.
Agriornis solitaria insolensGenus South Temperate; species Puna Zone.
Myjotheretes erythropygiusGenus South Temperate; species Puna Zone.
Ochthoeca oenanthoides polionotaGenus Andean Temperate; species Puna Zone.
Muscisaxicola albifronsGenus South Temperate; species Puna Zone.
Muscisazicola griscaGenus South Temperate; species Puna Zone.
Muscicaricola albiloraGenus South Temperate; species Puna Zone.
Muscisaricola rufivertex
Muscisazicola maculirostrisGenus South Temperate; species South Tem-
perate. Lessonia niger oreasGenus and species South Temperate; subspe-
<i>Lessonso nsoet orens</i> (Jenus Spot Species Notice Temperate: Silvede.
cies Puns Zone
cies Puna Zone. Orochelidon murina

Summary of distributional analysis of 88 Genera and 88 species taken in the puma bone. 16

GENERA.	
Of general distribution	27
Of South Temperate Zone origin	
Of Argentine origin	1
Restricted to the Temperate and Puna Zones	4
Restricted to the Puna Zone	
Total	58
SPECIES.	
Of general distribution	10
Found also in the South Temperate Zone	22
Found also in Chile	1
Restricted to the Temperate and Puna Zones	3
Restricted to the Puna Zone	46
Total	82

NORTH AMERICAN MIGRANTS.

The coast and the lakes and marshes of the tableland of Peru form the winter home or migration stations for a number of North American shore birds. Taczanowski records some 28 species, but of land birds comparatively few reach this country, only 15 being given by Taczanowski.

Our work having been done largely in the summer months we took comparatively few of these migrants. Totanus melanoleucus is recorded from Tinta and Tungasuca by Sclater and Salvin, Helodromas solitarius from Santa Ana by Berlepsch and Stolzmann, while Watkins secured two male Spotted Sandpipers at Calca, near Cuzco, on April 25, one of which had the sexual organs much enlarged.

The following North American land birds are recorded beyond:

Empidenaz trailli alnorum.

Vireosylva olivacea.

Dendroica caerulea.

Wilsonia canadensis.

Piranya rubra rubra.

LIST OF SPECIES AND SUBSPECIES IN THE URUBAMBA COLLECTIONS WHICH HAVE BEEN DESCRIBED AS NEW.

Micropus peruvianus, Proc. Biol. Soc. Wash., vol. 32, 1919, p. 253 (Ollantaytambo), — Micropus peruvius Berlepsch and Stolzmann.

Leptasthenura andicola peruviana, Bull. Amer. Mus. Nat. Hist., vol. 41, 1919, p. 327 (La Raya).

Siptornis urubambensis, Bull. Amer. Mus. Nat. Hist., vol. 41, 1919, p. 328 (Cedrobamba).

¹⁸ The richness of the Puna Zene avifauna of Peru as compared with that of Colombia is shown by the statement that only 15 genera and 18 species were found by us in the Paramo or Puna Zone of the last-named country. This comparatively limited life is due to the small extent of the area contained within the zone and also to its remoteness from the region in which Puna birds have their geographic origin.

Phacellodomus striaticeps griscipectus, Proc. Biol. Soc. Wash., vol. 32, 1919, p. 258 (Ttica-Ttica).

Mecoesculus subtropicalis, Proc. Biol. Soc. Wash., vol. 32, 1919, p. 263 (San Miguel Bridge).

Anaeretes agraphia, Proc. Biol. Soc. Wash., vol. 32, 1919, p. 263 (Idma).

Basileuterus luteoviridis superciliaris, Proc. Biol. Soc. Wash., vol. 32, 1919, p. 265 (above Torontoy).

Pheucticus uropygialis terminalis, Proc. Biol. Soc. Wash., vol. 32, 1919, p. 266 (San Miguel Bridge).

Pseudochloris uropygialis connectens, Bull. Amer. Mus. Nat. Hist., vol. 41, 1919, p. 329 (La Raya).

Catamenia analoides griseiventris, Proc. Biol. Soc. Wash., 1919, p. 267 (Cusco).

Atlapetes canigenis, Bull. Amer. Mus. Nat. Hist., vol. 41, 1919, p. 330 (Torontoy).

Diglossa mystacalis albilinea, Bull. Amer. Mus. Nat. Hist., vol. 41, 1919, p. 331 (Cedrobamba).

Oreomanes binghami, Bull. Amer. Mus. Nat. Hist., vol. 41, 1919, p. 331 (Cedrobamba)

—Oreomanes fraseri Sclater.

LIST OF SUBSPECIES DESCRIBED IN THIS PAPER.

Aratinga mitrata alticola, p. 68. Siptornis modesta proxima, p. 83. Ochthoeca lessoni tectricialis, p. 88.

DISTRIBUTIONAL LIST OF 380 SPECIES AND SUBSPECIES OF BIRDS KNOWN FROM THE URUBAMBA VALLEY.

This paper is offered primarily as a contribution to a biological survey of the Andean system. Such value as it may possess is to be found chiefly in the results of a comparative study of the origin of the bird life of the Temperate and Puna Zones from which our collections, if not complete, are at least fairly representative.

As a preliminary to the end in view it was necessary only that the identity of our specimens—constituting, as it were, the factors in the local problem under consideration—be determined and expressed in terms of current nomenclature. So far as possible I have, therefore, restricted my systematic work to the specimens contained in the collection. The fact, furthermore, that the American Museum, in the prosecution of its biological survey of South America, is now engaged in work in Peru makes it desirable to await the receipt of much additional material before attempting anything like revisions of the groups to which the species herein listed belong.

Failure to recognize genera recently described or recorded by various authors does not necessarily mean disapproval of their views. Generic subdivision in ornithology nowadays is so unstandardized and, in many cases, is so largely a matter of opinion, that it seems unwise to change long-established terms until opportunity has been afforded to weigh the evidence on which the new or revived genera in question are recognized.

Faunal papers treating of a small part of the known species of birds may be regarded as catalogues, rather than expositions of classification. To facilitate their use, particularly when as "extras" they appear without indices, their authors should, in my opinion, adopt a current, standard classification, even when it does not wholly embody their own views. I have, therefore, followed here Sharpe's order of arrangement as it is employed by Brabourne and Chubb in their Birds of South America, using also the enumeration of species given in that work. The addition of a letter to a number indicates that the species in question is not contained in Brabourne and Chubb's list.

Ridgway's Color Standards and Color Nomenclature (Washington, 1912) has been accepted as authoritative.

When no specimens are listed it is understood that the species is neluded on the authority cited.

DISTRIBUTIONAL SUMMARY.	
	mber
of sp	ecies.
Of general distribution	15
North American migrants	8
Tropical Zone	
Subtropical Zone	
Temperate Zone	
Puna or Paramo Zone	
Total	980
Total	380

Order CRYPTURIFORMES.

Family TINAMIDAE.

TINAMOUS.

(4) TINAMUS TAQ Temminck.

Tinamus tao Temminok, Pig. et Gallin., vol. 3, 1815, pp. 569, 749 ("Para, Bresil").

No comparison made with other specimens.

Rio Comberciato, 1 male; Rio Cosireni, 1 male; Rio San Miguel, 1 male, 1 female.

(7) TINAMUS MAJOR RUFICEPS Sciator and Salvin.

Tinamus ruficeps Sciater and Salvin, Nomen. Av. Neotr., 1873, p. 162 (Rio Napo, Ec.).

A male and female from the Rio Cosireni agree in color with average specimens from Colombia, but have a shorter wing, measuring, respectively, wing, 200 and 205 mm. as compared with an average of 230 mm. in the Colombian bird.

Rio Cosireni, 2.

(23) CRYPTURUS SOUI, subspecies.

Two males from the Rio Comberciato and a female from the Rio Cosireni represent an apparently undescribed race of this widely distributed and variable species. This material is not, however, in my opinion, sufficient to define satisfactorily the status and relationships of a Peruvian form, and rather than add to the confusion which already exists in this group I prefer to await the receipt of additional specimens before presenting my conclusions in this connection. Meanwhile it may be said that the males, one of which (Sept. 13) is marked as "breeding" are much grayer, less fulvous below than the males of any race known to me, while the female (Sept. 11) which is also marked as breeding, resembles in general coloration males from the island of Trinidad, but has the lower tail-coverts more rufous.

Rio Comberciato, 2; Rio Cosireni, 1.

(26) CRYPTURUS PARVIROSTRIS Wagler.

Crypturus parvirostris Wagler, Syst. Av. Gen. Crypturus, sp. 13, 1827 (Brazil).— Berlepsch and Stolzmann, Ornis, 1906, p. 101 (Santa Ana).

A female collected by Cherrie at Santa Ana compared with three males from Chapada, Matto Grosso, is darker above with the crown slaty, rather than brownish, and the underparts decidedly more slaty. These differences may be in part sexual but are doubtless also in part racial.

Brabourne and Chubb ¹⁰ have proposed to place this species and *C. tataupa* in a new genus for which they propose the name *Crypturellus*. Later ²⁰ Chubb, discovering that this name was preoccupied, replaced it with *Microcrypturus*; but in 1919, Ibis, p. 10, he continued to use *Crypturellus*. The characters ascribed to the new genus, however, seem at the best to be of not more than subgeneric value and in my opinion the species mentioned may be retained in the genus *Crypturus*.

Santa Ana. 1.

(49) NOTHOPROCTA FULVESCENS Berlepsch.

Nothoprocta fulvescens Berlepson Proc. 5th Int. Zool. Cong., 1902, p. 548 (Urcos, 3500 m., Dept. Cuzco, Peru).

I refer to this species, of which I have seen only the original description, two not fully mature specimens collected by Heller at Ollantaytambo. They have the flanks and abdominal region fulvous, as in *N. curvirostris*, but the secondaries are barred with rich fulvous, not with ferruginous as in that species, *N. perdicaria*, and *N. coquimbae*.

Ollantaytambo, 2.

Mann. Mag. Nat. Hist., vol. 14, 1914, p. 322.

Bull. Brit. Orn. Club., vol. 38, 1917, p. 30, under Crypturus obsoletus punensis.

(59) NOTHOPROCTA KALINOWSKII Berlepsch and Stolsmann.

Nothoprocta kalinowskii Berlepsch and Stolzmann, Ornis, 1901, p. 104; 1906, p. 104 (Licomachay near Cuzco).

(61) NOTHURA MACULOSA PERUVIANA Berlepsch and Stelamann.

Nothura maculosa peruriana Berliepech and Stolemann, Ornis, 1906, p. 101 (Santa Ana, Peru).

(63) NOTHURA MACULOGA BOLIVIANA Salvaderi.

Nothura boliviana Salvadori, Cat. Birds Brit. Mus., vol. 27, 1895, p. 561 (Bolivia).

Nothura maculosa boliviana Berlepsch and Stolemann, Ornis, 1906, p. 106 (Cuzco).

Order GALLIFORMES.

Family CRACIDAE.

CURASSOWS, GUANS, CHACHALACAS.

(92) PENELOPE SCLATERI PLUMOSA Berlepech and Stokmann.

Penelope sciateri plumosa Berlepsch and Stolzmann, Proc. Zool. Soc., 1902, p. 44 (Maraynioc, Peru).

Differs from Bolivian specimens as described by Berlepsch and Stolzmann.

Torontoy, 7,800-9,000 feet, 7.

(98) PENELOPE JACQUAÇU JACQUAÇU Spix.

Penelope jacquaçu Spix, Av. Bras., vol. 2, 1825, p. 52, pl. lxviii (Solimoëns).

Four specimens from the Tropical Zone agree with four from southeastern Colombia, and one from the Lower Beni, but two from the Rio Chimoré (1,300 feet, Prov. Cochabamba, Bolivia), have the malar stripe grayer, the crown feathers longer, more pointed and more widely bordered with gray; the wing coverts more widely margined with silvery white, and the rump greener. They thus agree with the description of *Penelope speciosa* Todd. It is difficult to believe, however, that the differences noted are more than subspecific when it seems probable that *speciosa* will prove to be the same as *P. boliviana* Reichenbach.

Rio Comberciato, 2 (one, Sept. 25, breeding); Rio Cosireni, 1 (Aug. 30, breeding); San Fernando, 1 (Sept. 20, breeding).

(112) ORTALIS GUTTATA (Spix).

Penelops guttata Sfix, Av. Bras., vol. 2, 1825, p. 55, pl. lxxii (Solimošns).

Ortalis guttata adspersa Berlepsch and Stolzmann, Ornis, 1906, p. 100 (Idma, 1 female).

Two males from the Rio Cosireni have the throat and breast darker with the margins to the feathers whiter and more clearly defined than in examples from southeastern Colombia. Should the difference be constant they should be known as *Ortalis guttata adspersus* (Tschudi).

Rio Cosireni, 2 (1, Oct. 20, "breeding").

(116) PIPILE CUMANENSIS (Jacquin).

Crax cumanensis Jacquin, Beytr. Gesch. Vögel, 1784, p. 25, pl. 10 (Orinoco).

This widely distributed bird of the Tropical Zone, is represented by four specimens collected by Heller between September 4 and 25, and marked by him as "breeding." I have no topotypical specimens for comparison.

Rio Comberciato, 4.

(121) ABURRIA ABURRI (Lesson).

Penelope aburri Lesson, Dict. Sci. Nat., vol. 59, 1829, p. 191 (Bogotá). Aburria aburri Berlepsch and Stolzmann, Otnis, 1906, p. 100 (Idma).

Two females agree with others from Bogotá, but are slightly smaller.

Rio Cosireni, 1; Rio San Miguel, 1, breeding (Sept. 29).

Family ODONTOPHORIDAE.

AMERICAN QUAILS AND PARTRIDGES.

(140) ODONTOPHORUS STELLATUS (Gould).

Ortyx stellata Gould, Proc. Zool. Soc., 1842, p. 183 (Brazil).

An immature female is apparently to be referred to this species. Rio Cosireni, 1.

Order COLUMBIFORMES.

Family COLUMBIDAE.

PIGEONS AND DOVES.

(147) COLUMBA ALBIPENNIS Sciator.

Columba albipennis Sclater, Proc. Zool. Soc., 1876, p. 18 (Pitumarca, Peru).— Berlepsch and Stolemann, Otnis, 1906, p. 104 (Cuzco).

Ollantaytambo, 3 (1 breeding, Aug. 10).

(152) COLUMBA RUFINA RUFINA Temminck and Knip.

Columba rufina TEMMINCK and KNIP, Pig., Proc., vol. 1, 1808-1811, p. 59, pl. 24 (French Guiana).

Columba rufina Sclatter and Salvin, Proc. Zool. Soc., 1876, p. 17 (Maranura).— Berlepsch and Stolzmann, Ornis, 1906, p. 100 (Santa Ana., Idma).

I am unable to separate three specimens from Peru and two from Bolivia from a Colombian series. The under tail coverts average darker but the difference is slight and bridged by individual variation, two of the Peruvian and one of the Bolivian birds having the under tail coverts quite as pale as in eastern Colombian example.

Santa Ana, 2; Idma, 1.

(154) COLUMBA ALBILINEA ALBILINEA Bonaparte.

Columba albilinea Bonaparte, Consp. Av., vol. 2, 1864, p. 51 (New Granada).

Two of our four specimens are adult and agree with Colombia examples.

Occobamba Valley, 3; above Torontoy (altitude 9,500 feet), 1.

(156a) COLUMBA PLUMBEA PROPINQUA Cory.

Columba plumbea propinqua Cory, Field Mus. Pub. 182, 1915, p. 205 (Moyobamba, Peru).

Columba plumbea andicola Chubb, Ibis, 1919, p. 33 (Central Peru to Bolivia).

A male from the Rio Comberciato and another from Santo Domingo, southeastern Peru, agree and apparently are not separable from a specimen from Buena Vista, eastern Colombia, labeled by Ridgway C. plumbea propinqua Cory. Mr. Chubb appears to have overlooked this race in his remarks on the forms of this species 21, as well as late publications on the same subject by Ridgway 22, and Chapman. 22

Rio Comberciato, 1.

(162) ZENAIDA AURICULATA PALLENS Bangs and Noble.

Zenaida auriculata pallens Bangs and Noble, Auk, 1918, p. 446 (Huancabamba, Peru).

This wide-ranging species is found from the Tropical up to the Temperate Zone. Specimens from the coast and tableland, both in Peru and Ecuador, are apparently alike and hence should be referred to this recently described race, the relationships of which with Z. hypoleuca Bonaparte remain to be determined. On the other hand, three males from the Cauca Valley, Colombia, agree with an equal number from Chile in having the chin scarcely lighter than the breast, the color of the latter extending backward to the vent with but little buff. The lower tail coverts in the Cauca birds, however, are more vinaceous than in those from Chile. Some Bolivian birds (Prov. Cochabamba) resemble Chilean examples; others are like those from Peru. Two adult males from Buenos Aires are paler, more glaucous below than any of those above mentioned, while a male from Chapada, Matto Grosso, Brazil, agrees in color and size with two others from Fernando Noronha off the coast of Brazil.²⁴

Unquestionably this species may properly be divided into several races, but their satisfactory definition requires more material than is at present available.

Santa Ana, 1; Ollantaytambo, 2; Huaracondo, 2; Cuzco, 1; Pisac, 6.

(170) GYMNOPELIA CECILIAE (Lesson).

Columba (Chamoepelia) ceciliae Lesson, Echo du Monde Sav., Jan. 12, 1845, col. 8 (Peru).

Chamaepelia erythrothorax Sclater and Salvin, Proc. Zool. Soc., 1869. p. 155 (Tinta).

Found by us in the arid Temperate and Puna Zones. It is interesting to observe that specimens from La Raya are referable to the present form, while a series from Tirapata, 60 miles farther south,

²¹ Ibis, 1919, pp. 31-33.

Birds of Middle and North America, vol. 7, 1916, pp. 324, 325.

²⁰ Bull. Amer. Mus. Nat. Hist., vol. 36, 1917, pp. 203-206.

²⁴ Zenaida auriculata noronha Chubb (Gray MS.), Ibis, 1919, p. 36.

agrees with the Bolivian race G. c. gymnops, which has been characterized by Chubb.

Ollantaytambo, 3; Chospiyoc, 2 (Apr. 15, 21, breeding); Huaracondo, 4; Cuzco, 4; La Raya, 6.

(176) CHAEMEPELIA MINUTA MINUTA (Linzacus).

Columba minuta Linnarus, Syst. Nat., vol. 1, 1766, p. 285 (Cayenne).

Chamaepelia griscola Sclater and Salvin, Proc. Zool. Soc., 1876, p. 17 (Maranura).

Columbigailina minuta Berlepsch and Stolzmann, Ornis, 1906, p. 100 (Santa Ana).

Inhabits the Tropical Zone.

Santa Ana, 6; Idma, 2.

(187) METRIOPELIA MELANOPTERA MELANOPTERA (Molina).

Columba melanoptera Molina, Hist. Nat. Chile, 1782, p. 308 (Chile).

Metriopelia melanoptera Sclater and Salvin, Proc. Zool. Soc., 1869, p. 155
(Tinta).

Restricted to the Puna Zone. Our specimens agree with a series from Tofo, Chile, and show no approach to the well-marked Ecuadorian form *M. m. saturatior* Chubb.

La Raya, 1; Pisac, 2.

(194) LEPTOTILA OCHROPTERA OCHROPTERA (Pelsein).

Leptoptila ochroptera Pelzeln, Orn. Bras., 1871, pp. 278, 451 (Sapitiba).—Sclater and Salvin, Proc. Zool. Soc., 1876, p. 17 (Potrero; Huiro).—Berlepsch and Stolzmann, Ornis, 1906, p. 100 (Santa Ana).

Inhabits the Tropical Zone ranging upward to the Subtropical. An excellent series agrees in color with three specimens from Paraguay (Rio Negro and Fort Wheeler) which I assume represent chloroauchenia, but the Peruvian birds are slightly smaller and should, I suppose, be referred to ochroptera. I have not, however, topotypical specimens of the last-named form and this identification must therefore be considered as provisional.

Santa Ana, 7; Idma, 1; San Miguel Bridge, 4; Machu Picchu, 1; Torontoy, 2.

(204) OREOPELEIA MONTANA (Linnaeus).

Columba montana Linnaeus, Syst. Nat., vol. 1, 1758, p. 163 (Jamaica).

A wide-ranging Tropical Zone species.

Rio Cosireni, 1 (Aug. 27, breeding).

(208) ORBOPELEIA FRENATA (Technic).

Columba frenata Tsohudi, Arch. für Naturg., vol. 1, 1843, p. 886 (E. Peru). Geotrygon frenata Berlepsch and Stolzmann, Ornis, 1906, p. 100 (Idma).

Rio San Miguel, 2 (1 breeding, Sept. 29).

Order RALLIFORMES.

Family RALLIDAE.

RAILS, GALLINULES, COOTS.

(221) PARDIRALLUS BYTIRHYNCHUS BYTIRHYNCHUS (Viciliot).

Rallus rytirhynchus Virillor, Nouv. Dict. d'Hist. Nat., vol. 28, 1819, p. 549 (Paraguay).

Pardirallus rytirhynchus rytirhynchus Bangs and Noble, Auk, 1918, p. 446 (Huancabamba, Peru).

Pardirallus rityrhynchus techudii Chubb, Ibis, 1919, p. 50 (central Peru; type from Lake Junin).

An excellent series of 19 specimens from northern Argentina, which may be considered as doubtless typically representing this species, shows some interesting differences in coloration and indicates that recently proposed forms of this species are apparently based on individual rather than racial variation. The dorsal surface in these specimens varies from plain, uniform olive-brown of varying shades. to essentially the same or somewhat paler color mottled with blackish, especially posteriorly. This blackish mottling is largely due to a wearing away of the tips of the feathers which exposes their blackish bases, but it is also individual, since some worn specimens, which are at the beginning of the postnuptial molt, do not exhibit it. The same range of variation is shown in five specimens from the Temperate Zone of Peru (including three from Lake Junin, type locality of P. r. tschudii Chubb). These specimens are somewhat larger than those from Argentina, but the difference is not in my opinion sufficiently pronounced to be of diagnostic value.

La Raya, 1; Calca, 1.

(231) ARAMIDES CAJANEA CHIRICOTE (Viellet).

Rallus chiricote Vienilor, Nouv. Dict. d'Hist. Nat., vol. 28, 1819, p. 551 (Paraguay).

A species of the Tropical Zone. Our specimen agrees with seven from Matto Grosso, Brazil.

Rio Comberciato, 1.

(252) CRECISCUS VIRIDIS FACIALIS (Technoli).

Crex facialis Techudi, Arch. für Naturg., 1843, p. 388 ("in sylvis peruanis calidris").

Creciecus viridis facialis Berlepsch and Stolemann, Ornis, 1906, p. 102 (Santa Ana).

(256) GALLINULA GALBATA GARMANI Allen.

Gallinula garmani Allen, Bull. Mus. Comp. Zool., 1876, p. 357 (Lake Titicaca). A Puna Zone representative of this wide-ranging species. Calca, 1.

(261) FULICA ARDESIACA Techudi.

Fulica ardesiaca Techudi, Arch. für Naturg., 1843, vol. 1, p. 389 (Peru).—Sclater and Salvin, Proc. Zool. Soc., 1869, p. 156 (Tungasuca).

(263) FULICA GIGANTEA Eydoux and Souleyet.

Fulica gigantea Eydoux and Souleyer, Voy. Bonite, 1841, p. 102, pl. 8 (Peru). Restricted to the Puna Zone.

La Raya, 1.

Order PODICIPEDIFORMES.

Family PODICIPEDIDAE.

GREBES.

(269) PODICEPS AMERICANUS Garnot.

Podiceps americanus Garnot, Voy. Coquille, Zool., vol. 1, 1829, p. 599 (Chile). Podiceps rollandi Schater and Salvin, Proc. Zool. Soc., 1869, p. 158 (Tungasuca).

(272) PODICEPS CALLIPARAEUS JUNINENSIS Berlepsch and Stolzmann.

P. calliperaeus juninensis Berlepsch and Stolzmann, Ibis, 1894, p, 112, prov. descr. (Lake Junin, Peru).

Podiceps calipareus Sclater and Salvin, Proc. Zool. Soc., 1869, p. 158 (Tungasuca).

Comparison of 13 specimens from Puno, 6 from Lake Junin, and 3 from La Raya, with 2 birds in breeding plumage from the Falkland Islands, confirms the subspecific distinctness of the race inhabiting the Puna Zone of Peru. Titicaca specimens average slightly larger than those from Junin and La Raya birds seem to be somewhat larger than either.

La Raya, 2 males, 1 female.

Order LARIFORMES.

Family LARIDAE.

SKIMMERS, GULLS, SKUAS.

(341) LARUS SERRANUS Tschudi.

Larus serranus TSCHUDI, Archiv für Naturg., 1844, vol. 1, p. 314 (Peru).—SCLATER and SALVIN, Proc. Zool. Soc., 1869, p. 158 (Tinta).

An abundant species of the Puna Zone, descending the streams to the Subtropical Zone.

Ollantaytambo, 1; San Miguel Bridge, 1.

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Order CHARADRIIFORMES.

Family THINOCORYTHIDAE.

SEED-SNIPE.

(359) THINOCORUS ORBIGNYANUS Gooffrey and Lesson.

Tinochorus orbignyanus Geoffeev and Lesson, Cent. Zool., 1832, p. 137, pls. 48, 49 ("San-Yago, Chili").

I have no Chilean material for comparison.

Occobamba Pass (13000 feet) above Ollantaytambo, 1 male, 2 females.

Family CHARADRIIDAE.

PLOYERS, SNIPES, Etc.

(369) HOPLOXYPTERUS CAYANUS (Latham).

Charadrius cayanus Latham, Ind. Orn., vol. 2, 1790, p. 749 (Cayenne).

Hoploxypterus cayanus Berlepsch and Stolemann, Ornis, 1906, p. 102 (Santa Ana).

(370) PTILOSCELYS RESPLENDENS (Technoli).

Charadrius resplendens TSCHUDI, Arch. für Naturg., 1843, p. 388 ("Antium incola," Peru).

Vanellus resplendens Schatter and Salvin, Proc. Zool. Soc., 1869, p. 156 (Tinta).

Common in and peculiar to the Puna Zone.

Lucma, 1 female.

(397) TOTANUS MELANOLEUCUS (Gmella).

Scolopax melanoleuca Gmelin, Syst. Nat., vol. 1, 1789, p. 659 (Lahrador).

Gambetta melanoleuca Sclater and Salvin, Proc. Zool. Soc., 1869, p. 156 (Tinta;

Tungasuca).

(899) HELODROMAS SOLITARIUS (Wilson).

Tringa solitaria Wilson, Amer. Orn., vol. 7, 1813, p. 53, pl. 58, fig. 3 (probably Pennsylvania).

Helodromas solitarius Berlepsch and Stolzmann, Ornis, 1906, p. 102 (Santa Ana, 2 males, Sept.).

I am unable to say whether the two specimens recorded by Berlepsch and Stolzmann are referable to the eastern or western form.

(400) ACTITIS MACULARIA (Empacus).

Tringa macularia Linnaeus, Syst. Nat., vol. 1, 1766, p. 249 (Pennsylvania).

Tringoides macularius Berlepsch and Stolzmann, Ornis, 1906, p. 102 (Santa Ana, Dec.).

Rio Comberciato, 1 female juv., Sept. 22, molting into first winter plumage; Calca, 1 male, Apl. 25 "testes much enlarged," 1 male, Apl. 25, "testes slightly enlarged," both in nuptial plumage.

(415) GALLINAGO BRAZILIENSIS ANDINA (Tecsanowski).

Scolopax andina Taczanowski, Proc. Zool. Soc., 1874, p. 561 (Lake Junin, Peru). Gallinago frenata Solater and Salvin, Proc. Zool. Soc., 1869, p. 156 (Tungasuca). Gallinago andina Solater and Salvin, Proc. Zool. Soc., 1876, p. 19 (Crit.).

These specimens agree with four others from Lake Junin. La Raya, 1; Ttica-Ttica, 1.

Order GRUIFORMES.

Family EURYPYGIDAE.

SUN-BITTERNS.

(485) EURYPYGA MAJOR MERIDIONALIS Beriepsch and Stelemann.

Eurypyga major meridionalis Berlepsch and Stolemann, Proc. Zool. Soc., 1902, p. 50 (La Merced, Peru).

Compared with five specimens from Panama, and one from Chocó, Colombia, two Peruvian birds support, in part, the characters on which this race is based. The russet banding on the outer primary is evidently variable in the same locality and not diagnostic, but the narrower black bands of the back, and clearer, more distinct markings on the neck seem to distinguish the Peruvian form.

Rio Cosireni, 1; (also Inca Mine, 1).

Order ARDEIFORMES.

Family IBIDIDAE.

TRISES.

(446) THERISTICUS BRANICKII Berlepsch and Stolumann.

Theristicus branickii Berlerson and Stolemann, Ibis, 1894, p. 404 (Lake Junin, Peru); 1900, pls. 9, 10.

Agrees with two specimens from Lake Junin. Occobamba Pass, 14,000 feet, 1 male.

(454) PLEGADIS RIDGWAYI (Allen).

Falcinellus ridgwayi Allen, Bull. Mus. Comp. Zool., vol. 3, 1876, p. 355 (Lake Titicaca).

Ibis falcinellus Schatzer and Salvin, Proc. Zool. Soc., 1869, p. 156 (Tungasuca)

Common in lagoons in the Puna Zone near the village of Huaracondo. No specimens were taken.

Family ARDEIDAE.

HERONS, BITTERNS, Etc.

(468) HERODIAS EGRETTA (Gmelin).

Ardea egretta Gmelin, Syst. Nat., vol. 1, 1789, p. 629 (Cayenne).—Sclater and Salvin, Proc. Zool. Soc., 1869, p. 156 (Tungasuca).

(470) NYCTICORAX NYCTICORAX TAYAZU-GUIRA (Vielliet).

Ardea tayazu-guira VIEILLOT, Nouv. Dict. d'Hist. Nat., vol 14, 1817, p. 417 (Paraguay).

(471) NYCTICOBAX CYANOCEPHALUS (Metina).

Ardea cyanocephala Molina, Saggio St. Chile, 1782, p. 156 (Chile).

Nycticorax obscurus Sclater and Salvin, Proc. Zool. Soc., 1869, p. 156 (Tinta).

The night herons of southern South America have long perplexed taxonomists, and with some 30 specimens before me I confess that I am no more able to reach wholly satisfactory results than have

been my predecessors. It is evident, however, from the material at hand, that there are two well-marked forms, a light and a dark. The dark form appears to be the only one found in Chile, where it ranges from the Straits of Magellan region northward. The light form appears to be the only one found east of the Andes, where it ranges from the Falkland Islands north, at least, to northern Argentina. Thus far the case seems clear, but when we reach the Andean table-land it is complicated by the occurrence of both forms, and what appears to be intergrades between them, from at least the vicinity of Cochabamba, Bolivia, to Lake Junin, Peru.

This intergradation is not a gradual merging of one form into another, since typical specimens of both dark and light forms were secured at the same place, within two days of each other, as appears from the appended consideration of table-land specimens.

Bolivia.—Vinto, 8,600 feet, Province Cochabamba. An unsexed, immature specimen taken July 7, streaked above and below, represents the dark form and resembles in size and color a bird of the same age from Ancud, Chile. The ground color below is ochraceous broadly streaked with black; the upper parts are blackish streaked with ochraceous.

Peru.—Puno, Lake Titicaca. A fully adult male with long nuptial plumes and enlarged sexual organs, taken July 26, is intermediate between cyanocephalus and naevius in color, but agrees with the former in size. (Wing, 319 mm.). It agrees very nearly with a male in similar stage of plumage from the Falkland Islands. An immature female, taken August 26, is typical of the light form and agrees in color and size with a specimen from Tafi del Valle, Province Tucuman, Argentina.

La Raya, 14,000 feet (about midway between Puno and Cuzco). A nearly adult male taken April 10, in much worn plumage and undergoing a complete molt into adult plumage, can be matched by specimens from Jujuy, Argentina, which are but slightly darker than average examples of naevius from the United States. An adult male in full molt, taken April 8, at La Raya, is fairly typical of the dark form and agrees essentially in color and in size with a bird of the same age from Temuco, Chile. Consequently we have from La Raya, taken within two days of each other, fairly typical specimens of tayazu-quira and cyanocephalus.

A nearly adult female in full molt, taken April 22 at Calca, in the Cuzco region, is typical of the light form and agrees with the La Raya female just mentioned. A young male taken March 13, at Junin is typical of the light form, while and adult male taken on the same day at the same place is intermediate between the light and dark forms. It is slightly darker than the intermediate specimen

from Puno, but very near a Falkland Island bird. Additional specimens, and particularly field studies, are needed to determine satisfactorily the status of these herons on the table-land of Bolivia and Peru, but the material examined in this connection (see list of specimens under table of measurements) shows, as stated above, the existence of a dark form in Chile and of a somewhat variable 25 light form in the Falkland Islands and Argentina, and doubtless Paraguay, Uruguay, and southern Brazil. The former has long been known as Nycticorax cyanocephalus, the latter has stood as Nycticorax tayazu-guira until 1914, when Mr. Hartert, 26 stating that Paraguayan birds were referable to naevius, applied that name to all the mainland birds east of the Andes and described the Falkland Island bird as Nycticorax cyanocephalus falklandicus.

I have no specimens from Paraguay, but it is not probable that they would differ materially from those in our excellent series from northern Argentina. Some of the latter can be matched by dark specimens of naevius from the United States, nevertheless it is quite evident that they belong to the form of naevius which inhabits southern South America, east of the Andes, for which Vieillot's name tayazu-quira, founded on Paraguay specimens through Azara, is available. To this form I refer Falkland Island as well as Titicaca and Lake Junin specimens. In other words, I follow Sharpe 27 rather than Hartert. As shown above, adults from the Falklands are essentially like adults from Peru, while an immature Falkland bird can be matched by one from Jujuy, Argentina. other words, the Falkland Island bird can not be separated from the light-colored mainland form either by color or by size. It is equally clear that, in spite of its variability, there is but one light-colored form of the Night Heron in southern South America, where it ranges from at least Lake Junin to the Falkland Islands, specimens from these two localities, as well as from Lake Titicaca being inseparable.

The relationships of the light form (tayazu-guira) to the dark form (cyanocephalus) are in doubt, but our specimens establish the fact that both occur together on the Peruvian tableland, where also intermediates between them are found. It is not impossible that the dark coloration is a partial dichromatism, constant in Chile, occasional on the tableland, and shown in a lesser degree by certain specimens from Peru, Argentina, and the Falklands. Since writing the above we have received an adult night heron from Panama, which is nearly as dark as Chilean specimens.

In size, the wing and tail average longer in the dark form. This difference is well shown by the two males from La Raya, one of which

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Almost as much variation is shown by naevius in the United States.

²⁸ Bull. Brit. Orn. Club, vol. 35, 1914, p. 15.

¹⁷ Cat. Birds Brit. Mus., vol. 26, pp. 155, 156.

is an extreme example of the light form, while the other is typical of the dark form. A male from the Falklands, however, is as large as some and but slightly smaller than other Chilean birds, while in two females from the Falklands the wing is shorter than in Chilean birds, but not quite so short as in Argentine specimens. In the length of the tarsus and bill there appear to be no diagnostic differences in size.

Measurements of males.

	Wing.	Tail.	Tarsus.	Bill.
Bertrand Island, Chile, immature 1		129	82	77
Do.¹		126 121	81	75 67. 5
Ancud, Chile, immature 1	322	118	85	71.5
Do.1	314	115	80	74
Perico, Jujuy, immature 2	312 290	120 117	90 80	78 72
Perico, Jujuy, adult 2		116	83	75
Puno, adult 3	319	129	82	77
La Ráya, adult ²		118 134	74 81	72 73
Junin, adult 3	307	130	83	77
Junin, immature 3	298	113	87	74

¹ Cyanocephalus.

Measurements of females.

	Wing.	Tail.	Tarsus.	Bill.
Bertrand Island, Chile, immature 1	310	128	77	70
Do.1		125	83	72
Do.1	316	127	79	72
Straits of Magellan, immature 1	300	120	77	71
Temuco, immature 1	320	127	83	73
Temuco, adult 1	313	118	81	67
Do.1		123	80	70
Falkland Island, immature 2	295	115	77	71
Falkland Island, adult 3		106	80	71. 5
Tafi del Valle, Tucuman, immature 3	280	101	l 78 l	66
Embarcacion, Salta, immature 3		99	78	68
Vinto, Bolivia, immature 1		117	83	67
Puno. Titicaca, immature *	298	120	87	75
Calca, Peru, adult 3	289	119	77	70

¹ Cyanocephalus.

(483) TIGRISOMA SALMONI Sciator and Solvin.

Tigrisoma salmoni Sclatte and Salvin, Proc. Zool. Soc., 1875, p. 38 (Lower Cauca River, Col.).—Beelepson and Stolemann, Ornis, 1906, p. 102 (Idma).

¹ Tayazu-guira.

^{*} Tayazu-guira.

Order ANSERIFORMES.

Family ANATIDAE.

DUCKS, GEESE, SWANS.

(501) CHLOEPHAGA MELANOPTERA (Eyton).

Anser melanopterus EYTON, Monog. Anat., 1838, p. 93 (Lake Titicaca).

Bernicla melanoptera Sclatze and Salvin, Proc. Zool. Soc., 1869, p. 157 (Pitumarca; Tinta).

Common in the Puna Zone.

Occobamba Pass, 14,000 feet, 1 male (July 25, mated); La Raya, 1 female.

(513) ANAS CRISTATA ALTICOLA Menegaux.

Anas cristata alticola Menegaux, Bull. Soc. Philom. Paris, vol. 10, 1909, p. 224 (Lake Poopo, Bolivia).

Compared with a large series from the Magellan region, Peruvian specimens confirm the validity of this race.

Cedrobamba, 13,000 feet, 1 male (breeding June 4). (We have also four specimens from Lake Junin.)

(517) NETTION OXYPTERUM (Meyen).

Anas oxyptera MEYEN, Nov. Act., vol. 16, 1838, Suppl., p. 121, pl. 26 (southern Peru).

Querquedula oxyptera Sciater and Salvin, Proc. Zool. Soc., 1869, p. 157 (Tungasuca; Tinta).

Occobamba Pass, 1 male.

(521) DAFILA SPINICAUDA (Viciliot).

Anas spinicauda VIEILLOT, NOUV. Dict. d'Hist. Nat., 1816, p. 135 (Buenos Aires).

Dafila spinicauda Sclater and Salvin, Proc. Zool. Soc., 1869, p. 157 (Tungasuca;

Tinta).

(524) QUERQUEDULA PUNA (Tachudi).

Anas puna Tachudi, Arch. für Naturg., 1844, p. 315 (Peru).

Querquedula puna Sclater and Salvin, Proc. Zool. Soc., 1869, p. 157 (Tungasuca).

(527) QUERQUEDULA CYANOPTERA ORINOMUS Oberholser.

Quarquedula orinomus Oberholser, Proc. Biol. Soc. Wash., 1906, p. 93 (Puna, Lake Titicaca).

Querquedula cyanoptera SCLATER and SALVIN, Proc. Zool. Soc., 1876, p. 17 (Tungasuca).

(529) SPATULA PLATALEA (Vielliet).

Anas platalea Virillot, Nouv. Dict. d'Hist. Nat., vol. 5, 1816, p. 157 (Buenos Aires).

Spatula platales Scilater and Salvin, Proc. Zool. Soc., 1876, p. 17 (Tungasuca).

(527) OXYURA FEREUGINEA (Eyten).

Erismatura farruginea Evron, Monog. Anat., 1838, p. 70 (Chile).—Berlepson and Stolzmann, Ornis, 1906, p. 105 (Vilcabamba).

La Raya, 1 male.

(545) MERGANETTA LEUCOGENYS LEUCOGENYS (Tachadi).

Anas leucogenis Tschudi, Arch. für Naturg., 1843, vol. 1, p. 390 (Andes of Peru).

Merganetta leucogenys Sclater and Salvin, 1869, p. 157 (Tinta).

Common in the streams of the Temperate Zone; less common in the Subtropical Zone. The female differs from the female of the Columbian species in the vermiculations of the sides of the neck, as described by Taczanowski. A pair seen July 22, in the Huaracondo Canyon were accompanied by two young in the down.

Occobamba Valley, 9,100 ft., 1 male, 1 female (mated); Lucma, 11,000 feet, 1 female; Huaracondo Canyon, 10,000 feet, 1 male, 1 female, 2 young (one family).

Order PELECANIFORMES.

Family PHALACROCORACIDAE.

CORMORANTS.

(549) PHALACROCORAX VIGUA VIGUA (Viellet).

Hydrocorax vigua VIEILLOT, Nouv. Dict. d'Hist. Nat., vol. 8, 1817, p. 90 (Paraguay). Phalacrocorax brasilianus Sclater and Salvin, Proc. Zool. Soc., 1876, p. 17 (Tungasuca).

Phalacrocorax vigua Berlefsch and Stolemann, Ornis, 1906, p. 102 (Santa Ana), Noted on the Urubamba between Santa Ana and Chauillay Bridge.

Order CATHARTIFORMES.

Family CATHARTIDAE.

CONDORS, VULTURES.

(565) SARCORAMPHUS GRYPHUS (Linnaeus).

Vultur gryphus Linnaeus, Syst. Nat., vol. 1, 1758, p. 12 (Chile).

Two condors were observed soaring high over the Urubamba River several miles above San Miguel Bridge. At Colpani, at the upper border of the arid Tropics, one was observed only a few hundred feet above the river, the condor, the black vulture, and turkey vulture all being observed at practically the same altitude on that day (July 9).

(567) CATHARISTA URUBU (Vicillot).

Vultur urubu Vieплот, Ois. Amer. Sept., vol. 1, 1807, p. 23, pl. 2. (Carolina and Florida).

Observed in the arid Tropics of the Santa Ana region. No specimens secured.

(568) CATHARTES AURA (subspecies?).

Vultur aura Linnarus, Syst. Nat., vol. 1, 1758, p. 86 (America calidiore). Observed in the arid Tropics. No specimens taken.

Order ACCIPITRIFORMES.

Family FALCONIDAE.

CARACARAS, FALCONS, HAWKS, Etc.

(576) IBYCTER MEGALOPTERUS (Meyen).

Aquila megaloptera MEYEN, Nov. Act. Caes., vol. 16, Suppl. 1, 1834, p. 64, pl. 7 (Chile).

Milvago megalopterus Sclater and Salvin, Proc. Zool. Soc., 1869, p. 155 (Tinta).

Inhabits the Puna Zone.

Above Torontoy, 14,000 feet, 1 male; Lucma, 13,000 feet, 1 male.

(583) CIRCUS CINEREUS Vielliot.

Circus cinereus Vieillot, Nouv. Dict. d'Hist. Nat., vol. 4, 1816, p. 454 (Paraguay).—Sclater and Salvin, Proc. Zool. Soc., 1869, p. 155 (Tinta).

Ttica-Ttica, 1 male adult.

(598) PARABUTEO UNICINCTUS (Temminck).

Falco unicinctus Temminck, Pl. Col., vol. 1, 1824, pl. 313 (Brazil).

Antenor unicinctus Berlepsch and Stolzmann, Ornis, 1906, p. 99 (Santa Ana).

(615) BUTEO ERYTHRONOTUS (King).

Haliaetus erythronotus, King, Zool. Journ., vol. 3, 1827, p. 424 (Straits Magellan). Buteo erythronotus Sclater and Salvin, Proc. Zool. Soc., 1869, p. 155 (Tinta).

We did not secure this species in the Urubamba region but in identifying the specimens of Buteo poecilochrous mentioned later, I have had occasion to examine our remaining specimens of this group from Puno, Lake Titicaca and southward to the Falkland Islands, and conclude that they are all referable to Buteo erythronotus. The series includes adults, or nearly adult birds, which are unmistakably erythronotus, from Puno, Lake Titicaca, Tofo, 60 miles north of Coquimbo, Chile; Tafi del Valle, Province Tucuman, Argentina; Uspallata Pass above Mendoza, Argentina, and the Falkland Islands. The remaining specimens present much variation due to age and dichromatism. Generally speaking, immature birds, in what I assume is postjuvenal plumage (first year) are broadly streaked below with black, or dark brown, the upper parts are fuscous with a minimum amount of ochraceous, the tail is dark gray narrowly and evenly barred with black, with no broader subterminal bar. In the succeeding plumage (second year) only the throat and breast are streaked, the abdominal region being thickly covered with broad, sometimes confluent ferruginous bars; there is usually more ochraceous or ferruginous in the dorsal surface, and at least a trace of a broad subterminal bar in some of the rectrices. In the following plumage (third year) the streaks have largely or wholly disappeared from the white breast, leaving the abdomen as in the preceding plumage; the ferruginous in the back has increased, in some specimens occupying the greater part of the dorsal surface much as in the adult, the subterminal tail bar is nearly if not quite as broad as in the adult, the rectrices are white, narrowly but evenly barred with blackish. This is followed by the fully adult plumage with white underparts, the bars, if any, confined to the sides and flanks, the tail white with broken bars or none, except a broad subterminal band, the back practically solid ferruginous. All but the tail-characters may be obscured by partial or complete melanism or erythrism. Thus an individual which has the tail of the postjuvenal plumage, is elsewhere almost wholly black, while two nearly adult birds from Puno and one from Tafi del Valle have the throat, breast and tibiae dark slate, the abdominal region rich chestnut more or less obscured with blackish in two specimens, in which the ferruginous above is also obscured with black. These comments are based on a series of 24 females. Apparently similar changes occur in the male, but my series of seven specimens of which singularly enough four are adult with white underparts and gray back, is too small to warrant a definite statement in this respect.

The series as a whole indicates that erythronotus is never wholly gray below and if this be true it seems evident that the relationships of poliosomus are with the poecilochrous-hypospodius group of which it may be the southern representative.

Measurements of Buteo erythronotus.

Place.	Sex and age.	Wing.	Tail.
Puno, Peru	Male adult	355	188
Tafi del Valle, Province of Tucuman, Argentina.	Male, first year	390	228
Do	do	362	220
Do	Male, third year	363	207
Mendoza, Argentina	Male, adult	365	193
Tofo, Chile	do	363	-192
Falkland Islands	do	363	193
Puno, Peru	Female, first year	402	234
Do	Female, third year	418	238
Do	Female, adult, melan	397	215
Do	do	404	211
Tafi del Valle, Province of Tucuman, Argen-	Female, first year	388	235
tina.			
Do	do	409	236
Do	do	402	242
Do	do	408	244
Do	Female, first year, me-	410	238
	lan.		
Do		388	219
Do	l do	399	224
Do	Female, third year	406	225
Do	Female, adult	417	228
Mendoza, Argentina	Female, first year	384	237
Do	Female, second year	383	219
Do	do	394	224
Tofo, Chile	Female, adult	392	200
Do	do	377	204
Santa Cruz, Argentina	Female, second year	393	230
Tierra del Fuero	Female, third year	400	232
Falkland Islands	Female, second year,	404	220
	melan.		

(\$18) BUTEO POECILOCHROUS Gurney.

Buteo poecilochrous Gurney, Ibis, 1879, p. 176 (Yanayacu, Ecuador).

Buteo melanosternus Berlepsch and Stolemann, Otnis, vol. 13, 1906, p. 104 (Cuzco).

No two of four hawks from La Raya are quite alike, nevertheless it is evident that they represent but one species. They agree in size with the measurements given for poecilochrous and an adult female agrees minutely with Gurney's description of that bird. A second female is mixed rufous and brown above with the abdominal region nearly uniform dark brown, the breast more ochraceous, the throat streaked with blackish, the tail gray, inner vanes of outer feathers and both vanes of central feathers whiter, all marked with wavy, darker gray bars which are more regular on the lateral feathers. third female is apparently more adult, being intermediate between the one just described and the bird resembling Gurney's type. male agrees with Gurney's plate of Buteo hypospodius 25 but has the lower abdomen and tibiae barred with gray and white, the throat white narrowly streaked with gray. An adult male from Mount Chimborazo, Ecuador, agrees closely with Gurney's plate in color but resembles the La Rava bird in size (see measurements that follow). If, as I assume, it represents the fully adult male of poecilochrous it is to be distinguished from the adult male of hypospodius only by its larger size.

Measurements of Buteo poscilockrous.

Place.	Sex and age.	Wing.	Tail.
Chimborazo, Ecuador	Famale adult	419 468	217 216 224 247 247 253

(626) RUPORNIS MAGNIROSTRIS OCCIDUA Bangs.

Rupornis magnirostris occidua Bangs, Proc. Biol. Soc. Wash., vol. 24, 1911, p. 187 (Rio Tambopata, Peru).

Rupornis nattereri Berlepsch and Stolemann, Ornis, 1906, p. 99 (Santa Ana).

These birds are intermediate between magnirostris and nattereri. They are in molt, the older plumage being brownish much as in nattereri, while the ingrowing plumage is grayer and more like that of magnirostris. The female is as gray below as the grayest magnirostris while the male has as much cinnamon on the chest and bars of the underparts as in some specimens of nattereri from Chapada, Matto Grosso.

Rio Comberciato, 1 male, 1 female.

[#] Ibis, 1876, pl. 3.

(650) SPIZIASTUR MELANOLEUCUS (Vicillot).

Spizaëtus melanoleucus Vieillot, Nouv. Dict. d'Hist. Nat., 1816, vol. 4, p. 482 (Guiana).

Geranoaëtus melanoleucus Sclater and Salvin, Proc. Zool. Soc., 1869, p. 155 (Tungasuca).

(658) CHONDROHIERAX UNCINATUS (Temminck).

Falco uncinatus TEMMINCE, Pl. Col., vol. 1, 1824, pls. 103-105 (Rio Janeiro).

Leptodon uncinatus Berlepsch and Stolzmann, Ornis, 1906, p. 99 (Echarate).

Idma, 1 female.

(669) FALCO FUSCO-CAERULESCENS Viciliot.

Falco fusco-caerulescens Vielllot, Nouv. Dict. d'Hist. Nat., vol. 11, 1817, p. 90 (Paraguay).

Hypotriorchis femoralis Sclater and Salvin, Proc. Zool. Soc., 1869, p. 155 (Tinta).

La Raya, female adult.

(677) CERCHNEIS SPARVERIA subspecies.

Tinnunculus sparverius Sclater and Salvin, Proc. Zool. Soc., 1869, p. 155 (Tinta); 1876, p. 17 (Maranura; Potrero).

Tinnunculus sparverius cinnamominus Berlepsch and Stolemann, Ornis, 1906, p. 100 (Santa Ana).

The sparrow hawk ranges from the Tropical Zone to the Puna and is everywhere more or less common. Pending a revision of the forms of this species, for which we have been some time securing specimens, I make no attempt to determine subspecifically the following examples.

Santa Ana, 1 female; Torontoy, 1 female; Ollantaytambo, 3 males, 3 females; Chospiyoc, 1 female; Ttica-Ttica, 1 male, 1 female; Calca, 1 male; Cuzco, 1 male, 2 females.

Order STRIGIFORMES.

Family BUBONIDAE.

OWLS.

(684) BUBO VIRGINIANUS NACURUTU (Vielliot).

Strix naeurutu Virillot, Nouv. Dict. d'Hist. Nat., vol. 7, 1817, p. 44 (Paraguay). Bubo virginianus Sclater and Salvin, Proc. Zool. Soc., 1869, p. 155 (Tinta).

Two specimens appear to be inseparable from a male from Corumbá, Brazil, and a female from Fort Wheeler, Paraguay, both of which may be considered as topotypical of nacurutu. These four birds are quite unlike three from the Straits of Magelian region (Tierra del Fuego, London Island, Rio Gallegos). The latter have the black markings, especially of the upper parts, of greater extent more intense and without a brownish tinge, the ochraceous markings much paler and less extensive and the pattern above much finer, the

vermiculations smaller. This material, therefore, evidently represents two well-marked races, for which Vieillot's name is applicable to the more northern.

Ttica-Ttica, 1; Ollantaytambo, 1.

(691-692) OTUS CHOLIBA (Vieillot).

Strix choliba Vielleot, Nouv. Dict. d'Hist. Nat., vol. 7, 1817, p. 39 (Paraguay). Pisorhina choliba Berlepsch and Stolzmann, Ornis, 1906, p. 99 (Santa Ana).

Found only in the Tropical Zone.

Rio Comberciato, 1 female; rufous phase (egg in duct, Sept. 13) Santa Ana, 1 male, 1 female; reddish brown phase; 1 female nestling (July 16).

(708) CICCABA HUHULA (Daudin).

Strix huhula DAUDIN, Traité Élém. et Complet d'Orn., vol. 2, 1800, p. 190

(Cayenne).

Syrnium huhuhm Berlepson and Stolzmann, Ornis, 1906, p. 99 (Santa Ana).

(716) SPECTYTO CUNICULARIA JUNINENSIS Berlepsch and Stolzmann.

Spectyto cunicularia juninensis Berlepsch and Stolzmann, Proc. Zool. Soc., 1902, vol. 2, p. 41 (Junin, Peru).

Pholeoptynx cunicularia Sclater and Salvin, Proc. Zool. Soc., 1869, p. 155 (Tinta).

This specimen is somewhat paler than any one of a series of six from Junin.

Pampa of Anta, near Huaracondo, 11,000 feet, 1 male.

(720) GLAUCIDIUM BRASILIANUM, subspecies.

Strix brasiliana Gmelin, Syst. Nat., vol. 1, 1788, p. 289 (Brazil).

An adult, in the gray phase of plumage, from the Temperate Zone. Ollantaytambo, 1 male.

(724) TYTO PERLATA, subspecies.

Strix perlata Sclater and Salvin, Proc. Zool. Soc., 1869, p. 155 (Tinta). Strix flammea perlata Berlepsch and Stolzmann, Ornis, 1906, p. 99 (Santa Ana).

Order PSITTACIFORMES.

Family PSITTACIDAE.

MACAWS, PARROTS, PARRAKERTS.

(756) ARATINGA MITRATA MITRATA (Tschudi).

Conurus mitratus Tschudi, Wiegm. Arch. für Naturg., 1844, p. 304 (Peru); Berlepsch and Stolemann, Ornis, 1906, p. 99 (Idma).

All our specimens were taken in the Subtropical Zone between April 28 and July 20. We have also seven specimens taken in this zone in Bolivia (Province Cochabamba and Province Santa Cruz) between September 24 and November 6.

This species has been said to visit the Temperate Zone at certain seasons, attracted by crops of grain, but our specimens from Cuzco

in the Temperate Zone, are clearly separable as a distinct though obviously representative form, the characters of which are discussed in connection with its description.

San Miguel Bridge (6,000 feet), 4 (June 29-July 20); Torontoy (8,000 feet), 5 (Apr. 28-July 20).

ARATINGA MITRATA ALTICOLA, new subspecies.

Subspecific characters.—Similar to Aratinga mitrata mitrata (Tschudi), but general color darker, less yellow, the under parts somewhat glaucous, the frontal band narrower, the cheeks with but few red feathers, the tibiae with no red.

Type.—No. 129,136, Amer. Mus. Nat. Hist., male adult, Cuzco, 11,000 feet, November 16, 1914; H. and C. Watkins.

Specimens examined.—Aratinga mitrata alticola. Peru: Typelocality, 1 male, 2 females. Aratinga mitrata mitrata. Peru: San Miguel Bridge, Urubamba Canyon, 6,000 feet, 1 male, 3 females; Torontoy, 7,800 feet, 4 males, 1 female. Bolivia: Tujima, 8,200 feet, Province of Cochabamba, 1 male, 1 female; Mizque, 7,500 feet, Province of Cochabamba, 1 male, 3 females; Rio Grande, 3,600 feet, Province of Santa Cruz, 1 (?).

Remarks.—The bird here described is evidently a zonal representative of Aratinga mitrata mitrata of which our 16 specimens are all from the Subtropical Zone, while alticola is a form of the Temperate Bolivian specimens of mitrata from the Subtropical Zone, when due allowance is made for seasonal variation, apparently agree with our Peruvian examples of this race from the same zone, showing that, in its zone, the species presents no racial variation in an area over 500 miles in length. When, however, in traveling but a few miles one passes from the Subtropical to the Temperate Zone, one goes also from the range of mitrata into that of alticola. Although so closely related to mitrata that its derivation from that form seems unquestionable, and although the ranges of the two forms merge into each other, our series of 19 specimens contains no examples which can not at once be referred to one form or the other. All the 16 specimens of mitrata have red on the tibiae, a variable number of red feathers scattered through the plumage, and only one is without red on the eye region. On the other hand, three specimens of alticola have no red on the tibiae, while the red in the body plumage is restricted to a narrow frontal band, the lores and a few feathers on the sides of the head. The differences in the tone of green mentioned in the diagnosis hold good throughout the series.

Lacking specimens of A. frontatus, I can make no comparison with that species in which the bend of the wing, tibiae, and crown, as well as forehead, are described as "scarlet."

(760) ARATINGA LEUCOPHTHALMA (Miller).

Psittacus leucophthalmus, P. L. S. MÜLLER, Syst. Nat. Suppl., 1776, p. 75 (Guiana).

A male has more or less red on the cheeks and bend of the wing, and measures wing, 180, tail, 150.5, culmen 31 mm. We have no topotypical specimens. (On the variations of this species see Hellmayr, Nov. Zool., vol. 14, 1907, p. 85.)

Rio Cosireni, 1 male.

(803) AMOROPSITTACA ANDICOLA (Finsch).

Psittacula andicola Finsch, Proc. Zool. Soc., 1874, p. 90 (Paucartambo, Peru)
Bolborhynchus orbignesius Sclater and Salvin, Proc. Zool. Soc., 1869, p. 154
(Tinta).

Bolborhynchus andicola Berlepsce and Stolemann, Ornis, 1906, p. 104 (Vilcabamba).

Ranges from the Subtropical to the Temperate Zone.

San Miguel Bridge, 2; Huaracondo Canyon, 2; Chospiyoc, 3; Calca, 1; Pisac, 1.

(834) AMAZONA FARINOSA INORNATA (Salvaderi).

Chrysotis inornata Salvadori, Cat. Birds Brit. Mus., vol. 20, 1891, p. 281 (Veragua).

Agrees with a specimen from Gatun, Canal Zone. Ridgway (Bull-U. S. Nat. Mus. No. 50, pt. 7) states that this form intergrades with true farinosa.

Rio Comberciata, 1 female (Sept. 25, breeding).

(835) AMAZONA MERCENARIA (Tochudi).

Psittacus mercenaria Tschudi, Faun. Per., 1846, p. 270, pl. 27 (Peru).

Amazona mercenaria Berlepsch and Stolzmann, Ornis, 1906, p. 99 (Idma).

Order CORACIIFORMES.

Family ALCEDINIDAE.

KINGFISHERS.

(899) CHLOROCERYLE AMERICANA AMERICANA (Gmelin).

Alcedo americana Ghelin, Syst. Nat., vol. 1, 1788, p. 451 (Cayenne).

Ceryle americana Berlepson and Stolzmann, Ornis, 1906, p. 96 (Santa Ana).

Family MOMOTIDAE.

MOTMOTS.

(917) MOMOTUS AEQUATORIALIS CHLOROLAEMUS Berlepsch and Stolzmann.

Momotus aequatorialis chlorolaemus Berlepsch and Stolzmann, Proc. Zool. Soc., 1902, vol. 2, p. 35 (Occobamba, Peru); Ornis, 1906, p. 96 (Idma).

Colombian specimens average browner both above and below, but several specimens in a series of 15 very nearly match the bird listed below.

Rio San Miguel, 4,500 feet, 1 female.

Family CAPRIMULGIDAE.

NIGHTJARS.

(938) UROPSALIS LYRA (Bonaparte).

Hydropsalis lyra BONAPARTE, Consp. Av., vol. 1, 1850, p. 59 (Colombia). ? Macropsalis lyra peruana BERLEPSCH and STOLZMANN, Ornis, 1906, p. 121 (Marcapata, Peru).

Our single specimen agrees in size and essentially in color, with a female from near Honda, Colombia. Berlepsch and Stolzmann appear to have based their proposed Peruvian race on comparison of but one specimen from Peru, with a male from Mérida, Venezuela. In view of this circumstance, it does not seem to be desirable to recognize at present a Peruvian form.

Torontoy, 1 female adult.

(943) HYDROPSALIS TORQUATA (Gmelin).

Caprimulgus torquatus Gmelin, Syst. Nat., vol. 1, 1789, p. 1032 (Brazil). Hydropsalis torquata Berlepsch and Stolzmann, Ornis, 1906, p. 96 (Idma).

Two specimens are somewhat darker than specimens from Matto Grosso, Santarem, and Bahia.

Rio Cosireni, 2 females (Aug. 27, eggs in ducts).

(948) NYCTIDROMUS ALBICOLLIS, subspecies.

Caprimulgus albicollis Gmelin, Syst. Nat., vol. 1, 1789, p. 1030 (Cayenne).

An adult male from the Tropical Zone agrees in general tone of color with a male from the Essequibo River (wing, 146; tail, 146 mm.), and is intermediate in size between that form and derbyanus. Additional material is required to determine the status of the south Peruvian bird.

Rio Cosireni, 1 male.

(955) THERMOCHALCIS RUFICERVIX (Sciater).

Stenopsis ruficervix Sclater, Proc. Zool. Soc., 1866, p. 140, pl. 14 (Colombia).

A single immature specimen furnishes no basis for comparison of Peruvian with Colombian material.

Chospiyoc, 1 immature.

(964) ANTROSTOMUS NIGRESCENS Cabanis.

Antrostomus nigrescens Cabanis, Schomb. Reis. Guian., vol. 3, 1848, p. 710, (British Guiana).

This specimen is slightly larger than British Guiana birds and has the wings more spotted, characters of subspecific value if they are constant.

Rio Cosireni, 1 female.

Family MICROPODIDAE.

SWIFTS.

(968) STREPTOPROCNE ZONARIS ZONARIS (Shaw).

Hirundo sonaris Shaw, in Mill. Cim. Phys., 1796, p. 100, pl. 55 (no type locality, Chapada, Matto Grosso, Brazil, proposed as type locality; see Chapman, Bull. Amer. Mus. Nat. Hist., vol. 38, 1914, p. 604).

Chaetura zonaris Berlepsch and Stolzmann, Ornis, 1906, p. 96 (Santa Ana).

Two specimens from the Tropical Zone agree in size with Matto Grosso specimens and in color and size with a specimen from near Rio. The latter was collected in 1916, while the Chapada birds, collected in 1883–1885, have evidently faded materially and are therefore browner in tone than freshly collected specimens.

Compared with the type of altissima, the two Peruvian birds have a narrower breast-band, less evident whitish margins on the bend of the wing, a darker forehead, and a bluer tone of color and are slightly smaller in size.

Lower Urubamba Canyon, altitude, 4,000 feet, 1 male, 1 female.

(962) CYPSELOIDES BRUNNETTORQUES BRUNNETTORQUES (Lafresmaye).

Chaetura brunneitorques Lafresnaye, Rev. Zool., 1844, p. 81 (Colombia).
Cypseloides brunneitorques Berlepsch and Stolemann, Ornis, 1906, p. 96 (Idma).

Our two specimens are from the Subtropical Zone. They agree with Colombian birds. The female has a broad rufous collar not so clear in color as in a Colombian male.

Torontoy, 1 male, 1 female.

(989a) MICROPUS PARVULUS Berlepsch and Stolumann.

M. andecolus parvulus Berlepsch and Stolzmann, Proc. Zool. Soc., 1892, p. 384, prov. descr. footnote (Ica, Peru).

Micropus peruvianus Chapman, Proc. Biol. Soc. Wash., vol. 32, 1919, p. 253, fig. 2. (Ollantaytambo, Peru.)

Specific characters.—Resembling Micropus andecolus (Lafresnaye and d'Orbigny), but tail shorter, less deeply forked, white areas of the plumage without buffy tints, forehead darker, basal under tail coverts with much less white. Tailed forked for 13.5 mm.

Common in the Temperate Zone and ranging downward to the upper limits of the Subtropical Zone. Doctor Hellmayr calls my attention to a provisional description of this form, as quoted above.

Ollantaytambo, 2; Huaracondo Canyon, 2; Torontoy, 2.

(991) MICROPUS MONTIVAGUS (d'Orbigny).

Cypselus montivagus d'Orbigny, Voy. Amer. Mer., 1835-1844, p. 357, pl. 42, fig. 1 (Samaypata, Bolivia).

Compared with a female from the Province of Santa Cruz, Bolivia, this Peruvian bird is blacker and has no white in the tail.

Torontoy, 1 female.

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Family TROCHILIDAE.

HUMMINGBIRDS.

(1005) PHOETHORNIS GUY EMILIAE Bourcier and Muleant.

Phoethornis emilias BOURCIER and MULSANT, Ann. Sci. Phys. et Nat. Lyon, vol. 9, 1846, p. 317 (Bogotá).

Phaethornis guyi Schater and Salvin, Proc. Zool. Soc., 1876, p. 16 (Huiro).

Agrees with Colombian specimens but has the white terminal part of the central rectrices narrower.

Rio San Miguel, 4,500 feet, 1 male.

(1057) EUPETOMENA MACROURA HIRUNDO Gould.

Eupetomena kirundo Gould, Ann. Mag. Nat. Hist., vol. 16, 1875, p. 370 (Huiro, Santa Ana Valley, Peru), Schatzr and Salvin, Proc. Zool. Soc., 1876, p. 18 (Huiro).

Eupetomena macroura hirundo Berlepsch and Stolzmann, Ornis, 1906, p. 94 (Santa Ana).

Common at Santa Ana.

Santa Ana, 3 males, 1 female (July 10-16).

(1005) PATAGONA GIGAS (Violitot).

Trochilus gigas Vieillor, Gal. Ois., vol. 1, 1825, p. 296, pl. 180 ("Bresil").

Patagona gigas Sclater and Salvin, Proc. Zool. Soc., 1869, p. 154 (Tinta).

A common species in the arid Temperate and Puna Zones. Our specimens were taken in the months of April, July, and November. A male collected in the last-named month is marked by Heller as "breeding."

La Raya, 1 male, 1 female; Pisac, 2 males, 4 females; Cuzco, 4 males, 2 females; Ttica-Ttica, 1 male, 1 female; Huaracondo Canyon, 1 male, 1 female; Chospiyoc, 3 males; Ollantaytambo, 3 males, 3 females.

(1066) LEUCIPPUS LEUCOGASTER (Technoli).

Trochilus leucogaster TSCHUDI, Arch. für Naturg., 1844, vol. 1, p. 297 (Peru).

Leucippus chionogaster Sclatze and Salvin, Proc. Zool. Soc., 1876,
p. 17 (Huiro).

Santa Ana, 1 female (July 15).

(1966) LEUCIPPUS VIRIDICAUDA Berlepsch.

Leucippus viridicauda Berlepsch, Ibis, 1883, p. 493 (Huiro, Peru); Ornis, 1906, p. 96 (Idma).

Ranges from the Subtropical to the Temperate Zone.

Idma, 1 female, 1 † (July 14); San Miguel Bridge, 3 males, 1 female (June 18-July 18); Ollantaytambo, 1 male, 1 female (Nov. 12; breeding).

(1150) CHLOROSTILBON PRASINUS DAPHNE Goald.

Chlorostilbon daphne Gould, Introd. Troch., 1861, p. 177 (Pampas del Sacramento, Peru).

Chlorostilbon prasinus SCLATER and SALVIN, Proc. Zool. Soc., 1876, p. 17 (Huiro). Chlorostilbon prasinus daphne Berlepsch and Stolemann, Ornis, 1906, p. 96 (Santa Ana).

Santa Ana, 4 males, (July 15); San Miguel Bridge, 4 males (June 29-July 9).

(1189) COLIBRI CYANOTUS (Beurder and Mulsant).

Trochilus cyanotus BOURCIER and MULSANT, Ann. Soc. Agric. Lyon, vol. 6, 1844, p. 41 (Caracas).—Berlepsch and Stolzmann, Otnis, 1906, p. 95 (Idma).

(1190) COLIBRI IOLATA (Gould).

Petasophora iolata Gould, Proc. Zool. Soc., 1847, p. 9 (Bolivia).
Colibri iolatus Berlepsch and Stolemann, Ornis, 1906, p. 95 (Idma).

This wide-ranging species is common in the Temperate Zone and two specimens were taken in the Subtropical Zone.

Idma, 1 male (Oct. 13); Torontoy, 1 male (Apr. 26); Ollantay-tambo, 1 male, 2 females (July 5); Chospiyoc, 2 males (Apr. 21); Pisac, 5 males, 1 ? (Apr. 17-18); Ttica-Ttica, 3 males, 3 females (July 2-3).

(1212) OREOTROCHILUS ESTELLA (d'Orbigny and Lafresnaye).

Trochilus estella d'Orbigny and Lafresnaye, Mag. de Zool., 1838, p. 32 (Mojos, Bolivia).

Common in the Puna Zone.

Above Machu Picchu, 13,000 feet, 1 male (June 11); Ttica-Ttica, 5 males, 1 female (July 2).

(1228-1230) HELIODOXA LEADBEATERI Bourcier and Muisant.

Heliodoxa leadbeateri Bourcier and Mulsant, Ann. Soc. Agric. Lyon, vol. 6, 1843, p. 43 (Caracas).

The females listed below and one from Locotal, Bolivia, are less solidly green below than some Colombian specimens and lack the bronze tint of others, but there is so much variation shown by Colombian specimens in this respect, that the differences mentioned cannot certainly be considered as racial. I am unable to separate males from Bolivia, Peru, Colombia and Merida, Venezuela.

Idma, 1 male, 2 females (July 14).

(1244) HELIANTHEA OSCULANS Gould.

Helianthea osculans GOULD, Proc. Zool. Soc., 1871, p. 503 (Esachupata, Peru).

Torontoy, 2 males (May 6, July 21).

(1258) HELIANTHEA INCA (Gould).

Bourcieria inca Gould, Contr. Orn., 1852, p. 136 (Coroico, Bolivia).

We have no Bolivian specimens.

San Miguel Bridge, 1? (July 19); Torontoy, 3 males (July 20-21), 1 male (Nov. 2).

(1254) HELIANTHEA COELIGENA OBSCURA (Berlepuch and Stelsmann).

Lampropygia columbiana obscurs Berlerson and Stolemann, Proc. Zool. Soc., 1902, vol. 2, p. 23 (Vitoc, Peru); Ornis, 1906, p. 95 (Idms).

Differs from an excellent topotypical series of columbiana as described by Berlepsch and Stolzmann.

Idma, 1 male, 1 female (July 14).

(1272) PTEROPHANES CYANOPTERUS (Praser).

Trochilus cyanopterus FRASER, Proc. Zool. Soc., 1840, p. 17 ("Sta. Fé de Bogota").

P. temminchi Boissonneau, cf. Bangs and Penard, Bull. Mus. Comp. Zool., vol. 63, 1919, p. 24.

Apparently inseparable from Bogotá specimens. Cedrobamba, 14,000 feet, 2 females (June 8).

(1277) AGLABACTIS CASTELNAUDI (Bourcier and Muleant).

Trochilus castelnaudi Bourcier and Mulsant, Rev. Zool., 1848, p. 270 (Cuzco). Above Ollantaytambo, 1 male (Nov. 7, breeding).

(1281) BOISSONNEAUA MATTHEWSI (Bourder).

Trochilus matthewsi Bourcier, Proc. Zool. Soc., 1847, p. 43 (Peru).

Panoplites matthewsi Sclater and Salvin, Proc. Zool. Soc., 1876, p. 16 (Huiro). Boissonneaua matthewsi Berlepsch and Stolemann, Ornis, 1906, p. 95 (Idma).

Idma, 1 male, 1 female (July 12, 13); San Miguel Bridge, 3 males (June 18, 19); 1 female (July 8).

(1293) VESTIPEDES SAPPHIROPYGIA (Taczanowski).

Eriocnemis sapphiropygia TACZANOWSKI, Proc. Zool. Soc., 1874, p. 139 (Maraynioc, Peru).

I have seen no other specimens.

Above Machu Picchu, 13,000 feet, 1 male (May 21).

(1313) OCREATUS ANNAE (Berlepsch and Stolsmann).

Spathura annae Berlefsch and Stolzmann, Ibis, 1894, p. 398 (Chanchamayo, Peru); Ornis, 1906, p. 95 (Idma).

? Steganura addae Sclater and Salvin, Proc. Zool. Soc., 1876, p. 16 (Huiro).— Berlepsch and Stolzmann, Ornis, 1906, p. 95.

Idma, 2 males, 3 females (July 12-14); San Miguel Bridge, 1 female (July 20); Rio San Miguel, 1 female (Oct. 4).

(1821) ADELOMYIA MELANOGENYS CHLOROSPILA Gould.

Adelomyia chlorospila Gould, Ann. Mag. Nat. Hist., 1872, p. 452 (San Antonio, "Peruvian Andes").

Adelomyia melanogenye Berlepsch and Stolzmann, Otnis, 1906, p. 96 (Idma).

Compared with a series of A. melanogenys maculata from Ecuador, these birds have the tail tips equally broad, somewhat deeper in color and more rounded terminally, the bases of the rectrices with less or with no pale brownish.

Idma, 1 male (July 14); San Miguel Bridge, 1 female, 1 (July 19).

(1880) HELIANGELUS AMETHYSTICOLLIS (d'Orbigny and Lafresnaye).

Orthorhynchus amethysticollis d'Orbieny and Lapresnaye, Mag. de Zool., vol. 8, 1838, p. 31 (Yuracares, Bolivia).

We have no Bolivian specimens.

Torontoy, 8,000 feet, 1 male (Nov. 2); Cedrobamba, 12,000 feet 1 male (June 6).

(1346) METALLURA AENEOCAUDA (Gould).

Trochilus aeneocauda Gould, Proc. Zool. Soc., 1846, p. 87 (Bolivia).

Compared with Bolivian specimens, those from Peru have the throat yellower green, and the tail, seen from below, more coppery. Cedrobamba, 2 males, 2 females (May 23-June 16).

(1250) METALLURA SMARAGDINICOLLIS SMARAGDINICOLLIS (d'Orbigny and Lafresnaye).

Orthorhynchus smaragdinicollis d'Orbigny and Lafresnate, Mag. de Zool., vol. 8, 1838, p. 31 (Yungas, Bolivia).

Hartert ²⁶ refers south Peruvian specimens to this form. I have no material for comparison.

Torontoy, 10,700 feet, 1 (May 10).

(1353) ORBONYMPHA NOBILIS Gould.

Oreonympha nobilis GOULD, Proc. Zool. Soc., 1869, p. 295 (Tinta, Peru).

Common in the arid Temperate and Puna Zones.

Ollantaytambo, 2 females (July 5, 12); Huaracondo Canyon, 2 males, 3 females (July 23); Chospiyoc, 1 male, 1 female (Apr. 18 and 20); Pisac, 4 females (Apr. 17–19); Cuzco, 1 male.

(1362) CHALCOSTIGMA STANLEYI VULCANI (Gould).

Ramphomicron vulcani GOULD, Contrib. Orn., 1852, p. 135 (Bolivia).

An adult male differs from an Ecuadorian series of stanleyi in having the purple of the back reach to the forehead, the underparts sooty with purplish reflections, the throat-pendant glittering plumbeous rather than amethyst. It should apparently be referred to the Bolivian form of which, however, I have seen only an immature specimen.

Idma Road, 11,200 feet, 1 male (Oct. 9); Occobamba Valley, 9,100 feet, 1 female (Aug. 2).

(1363) CHALCOSTIGMA OLIVACEUM (Lawrence).

Ramphomicron olivaceus Lawrence, Ann. Lyc. New York, 1864, vol. 8, p. 44 (La Paz).

Agrees with a specimen from Maraynioc, but is considerably paler than an immature, poorly prepared specimen from La Paz, Bolivia. Lucma-Cosireni Pass, 11,400 feet, 1 male (Oct. 7).

(1375) CYANOLESBIA MOCOA SMARAGDINA (Gould).

Trochilus smaragdinus Gould, Proc. Zool. Soc., 1846, p. 85 (Bolivia).

Our specimens agree with others from Bolivia. Idma, 2 males (July 14).

[■] Nov. Zool., 1899, p. 73.

(1391) PSALIDOPRYMNA NUNA (Lesson).

Ornismya nuna Lesson, Suppl. Ois. Mouches, 1831, p. 169, p. 35 (Peru).

Ollantaytambo, 3 males (Nov. 10-12, breeding), 1 ? (July 5); Chospiyoc, 2 males (Apr. 20); Calca, 3 females (Apr. 17-25); Pisac, 1 female (Apr. 20), Cuzco, 1 male.

(1418) CALLIPHLOX AMETHYSTINA (Gmella).

Trochilus amethystina Gmelin, Syst. Nat., 1788, vol. 1, p. 496 (Cayenne).

Calliphlox amethystina Berlepsch and Stolemann, Ornis, 1906, p. 96 (Idma).

Agrees with a male from Merida, Venezuela. We have no Guiana specimens.

Rio Cosireni, 1 male.

(1420) CHARTOCERCUS MULSANTI (Boarder).

Ornismya mulsanti Bourgier, Ann. Sc. Phys. et Nat., Lyon, 1842, vol. 5, p. 344, pl. 20 (Colombia).

Accetrura mulsanti Sclater and Salvin, Proc. Zool. Soc., 1876, p. 16 (Huiro).

Order TROGONES.

Family TROGONIDAE.

TROGONS.

(1451) PHAROMACHRUS ANTISIENSIS (d'Orbigny).

Trogon antisiensis d'Orbigny, Mag. Zool., 1837, Class II, pl. 85 (Yungas, Bolivia). Pharomacrus antisianus Berlepsch amd Stolemann, Ornis, 1906, p. 97 (Idma).

(1452) PHAROMACHRUS AURICEPS (Gould).

Trogon auriceps Gould, Ann. Mag. Nat. Hist., 1842, vol. 9, p. 238 ("Quito"). Pharomacrus auriceps Berlepsch and Stolzmann, Ornis, 1906, p. 97 (Idma).

An adult male with enlarged testes, taken July 19, agrees in size with specimens from western Ecuador. Comparison of adequate series from eastern and western Ecuador shows that the former average larger and slightly greener. The differences, however, do not appear to be constant enough to warrant the recognition of two races. Nor in any event could this be done satisfactorily without an examination of Gould's type, which, said to have come from "Quito," may have been collected on either the Amazonian or Pacific slope of the Andes. A male from Incachaca, Province of Cochabamba, shows that this Trogon ranges throughout the Subtropical Zone from Venezuela to Bolivia.

San Miguel Bridge, 1 male.

(1457) TROGONURUS PERSONATUS (Gould).

Trogon personatus Gould, Ann. Mag. Nat. Hist., vol. 9, 1842, p. 237 (Andes of Peru).—Berlepsch and Stolemann, Ornis, 1906, p. 97 (Idma).

(1458) TROGONURUS COLLARIS COLLARIS (Viciliot).

Trogon collaris VIEILLOT, Nouv. Dict. d'Hist. Nat., vol. 8, 1817, p. 330 (Cayenne).

Apparently to be referred to this form rather than to virginalis of western Ecuador. The male has the white tail-bands even broader than in one from eastern Ecuador, which in default of Cayenne specimen I accept as representing collaris, but the female is more dusky on the lores and auriculars than an east Ecuador bird, though not so much so as in the west Ecuador bird.

Rio Cosireni, 1 male, 1 female.

(1407) TROGONURUS BOLIVIANUS (Grant).

Trogon bolivianus Grant, Cat. Birds Brit. Mus., 1890, vol. 17, p. 470, pl. 15 (Cosnipata, Peru).

Our specimens confirm the validity of this species, and show that it ranges at least from the Beni River in Bolivia to the base of the eastern Andes in Colombia. Specimens from the Provinces of Cochabamba and Santa Cruz agree with a series from Chapada. Matto Grosso, and evidently represent Trogonurus variegatus. Hellmayr 20 recognizes the Bolivian form under the name Trogon variegatus behni, on the basis of larger size and shorter white tips to the outer rectrices, but in the absence of topotypical specimens of variegatus I am unable to say whether our Bolivian birds are separable. There can, however, be no doubt of their distinctness from bolivianus, which has broader black and narrower white bands on the tail; the throat, and breast largely or wholly purple, and with a narrower white band or none at all; and, as a rule, greener, less brassy back and bluer rectrices. These characters are most highly developed in our Colombian birds, but the Beni River specimen has less white in the tail than any other in the series.

Specimens examined.—Trogonurus bolivianus. Bolivia: Beni River, 1 male, 1 female. Peru: Rio Tavara (long. 70° 20'; lat. 13° 25'), 1 male; Rio Cosireni, 2 males (the type locality is about halfway between these two places). Ecuador: 1. Colombia: La Morelia, 1 male, 1 female, tail imperfect; Andes above La Morelia (2,500 feet), 1 male. Trogonurus variegatus "behni." Bolivia: Roquefalda, Province Cochabamba, 1 male; Rio Chimorié, Province of Cochabamba, 1 male; Todos Santos, Province of Cochabamba, 5 females; Vermejo, Province of Santa Cruz, 2 males. Brazil: Chapada, Matto Grosso, 8 males, 2 females.

[™] Nov. Zool., 1906, vol. 15, p. 88.

Order COCCYGES.

Family CUCULIDAE.

CUCKOOS, ANIS.

(1488) PIAYA CAYANA OBSCURA Snothings.

Piaya cayana obscura SNETHLAGE, Journ. für Ornith., 1908, p. 21 (Bom Lugar, Rio Verde, upper Purus, Brazil).

Piaya cayana boliviana STONE, Proc. Acad. Nat. Sci. Phila., 1906 (pub. Jan., 1909), p. 500 (Yungas, Bolivia).

Piaya cayana Sclater and Salvin, Proc. Zool. Soc., 1876, p. 17 (Huiro).

Piaya cayana nigricrissa Berlepson and Stolemann, Ornis, 1906, p. 97 (Santa Ana).

I am unable to separate our specimens from six from Bolivia (Locotal, 3; Rio Chaparé, 3) and one from Tres Buritys River, Matto Grosso, Brazil. Hellmayr³¹ refers specimens from Calama, Rio Madeira, to *obscura*, which apparently, therefore, is the name to be applied to birds from Bolivia and southern Peru.

Rio Cosireni, 1; San Miguel Bridge, 1; Uchumayo, Urubamba Canyon, 1; Rio San Miguel, 1.

(1496) TAPERA NAEVIA (Lienacus).

Cuculus naevius Linnabus, Syst. Nat., vol. 1, 1766, p. 170 (Cayenne). Diplopterus naevius Sciater and Salvin, Proc. Zool. Soc., 1876, p. 17 (Maranura). Tapera naevius Berlepsch and Stolzmann, Ornis, 1906, p. 97 (Santa Ana).

(1499) CROTOPHAGA ANI Linnous.

Crotophage and Linnabus, Syst. Nat., vol. 1, 1768, p. 105 (Brazil).—Sciater and Salvin, Proc. Zool Soc., 1876, p. 17 (Maranura; Potrero).—Berlepsch and Stolemann, Ornis, 1906, p. 97 (Santa Ana).

A wide ranging species of the Tropical Zone. Santa Ana, 1; San Miguel Bridge, 3.

Order SCANSORES.

Family CAPITONIDAE.

BARBETS.

(1510a) CAPITO AURATUS INSPERATUS Cherrie.

Capito auratus insperatus Cherrie, Bull. Amer. Mus. Nat. Hist., vol. 35, p. 391 (Todos Santos, Rio Chaparé, Bolivia).

Capito punctatus (not Lesson?), subspecies, Berlepsch and Stolzmann, Ornis, vol. 13, 1906, p. 123 (Rio Cadena, southeastern Peru).

Hellmayr 22 records specimens of Capito from the Province of Huanuco with which he writes birds from "Bogota" agree. Capito auratus auratus (Dumont) thus inhabits the tropical zone at the eastern base of the Andes from Colombia to northern Peru. A

female from the Rio Cosireni, however, has an unspotted throat and is clearly, therefore, not to be referred to true auratus. The identification of this specimen has necessitated a study of the specimens of the auratus group in our collections, including topotypes of auranticinctus Dalmas, and the type of insperatus Cherrie, to which, through the kindness of Mr. Bangs, has been added the type of bolivianus Ridgway, in which the following conclusions have been reached:

CAPITO AURATUS AURATUS (Dument).

The female is distinguished from other members of the group by its heavily spotted throat. In the male the crown averages darker than in other forms, ranging from brownish olive to Saccardo's olive tinged anteriorly with old gold. Colombian specimens can be matched in this respect by Orinoco birds (auranticinctus), but in the latter the crown averages paler, the yellow areas deeper, and the rump and abdomen are often marked with orange.

Specimens examined—Colombia: Buena Vista, above Villavicencio, 4 males, 4 females; La Morelia, 1 female; "Bogota," 1 female Ecuador: Napo, 1 female; Marafion, 1 male; "Ecuador," 1 male.

CAPITO AURATUS AURANTIICINCTUS Dalmas.

Capito aurantiicinctus Dalmas, Bull. Soc. Zool. France, 1900, p. 178 (Caura River, Ven.).

Capito auratus intermedius BERLEPSCH and HARTERT, Nov. Zool., vol. 9, 1902, p. 98 (Nericagua, upper Orinoco, Ven.).

Capito auratus bolivianus RIDGWAY, Proc. Biol. Soc. Wash., vol. 25, 1912, p. 87.

Further examination of our material from the Orinoco confirms my belief that there is but one form in this region. The orange abdominal band and orange marked rump, said to be characteristic of aurantiicinctus, is evidently not constant. In one of our males from La Union, on the lower Caura, this feature is pronounced, in the other it is wanting below and barely suggested above. In two males from the Cunucunuma River, the band below is well-marked, in three others it it less evident. Three of these birds have orange on the rump, in the fourth this character is lacking. In view of this variability in the character which is alleged to separate intermedius from aurantiicinctus, and the proximity of the Cunucunuma to the type locality of intermedius, I am convinced that the latter is not a valid race and I refer all our Orinoco specimens to aurantiicinctus.

Specimens examined.—La Union, Caura River, Venezuela, 2 males (topotypes); Boca de Sina, Cunucunuma River (near Mount Duida), Venezuela, 4 males, 2 females.

CAPITO AURATUS INSPERATUS Cherrie.

The crown in this race is paler than in any of the other forms, being in both sexes uniformly sulphine-yellow; a color not shown in the

crown of other races; the nape is not materially darker than the forehead. Males do not exhibit the orange on the rump and abdomen, which is found in most, but not all, specimens of auranticinctus. Females of insperatus can be distinguished from our females of auranticinctus only by their much paler, uniformly colored crown.

Specimens examined.—Bolivia: Todos Santos, Province of Cochabamba, 4 males, including the type, 1 female; Mission San Antonio, Province of Cochabamba, 3 females; Rio San Antonio, 1 female; "Bolivia," 1 female. Peru: Rio Cosireni, 1 female; Astillero, Rio Tambopata, 1 male.

CAPITO AUBATUS BOLIVIANUS Ridgway.

The type of this race, a male, is now before me. It was found by Dr. Thomas Barbour attached to an Indian necklace in a museum in La Paz, Bolivia, and was supposed to have come from the Rio Beni. It is the most richly colored bird in our series, but can be nearly matched by a male from the Cunucunuma River. The underparts of the type are deeper, and there is a trace of an orange abdominal band; the crown is antique brown with an old gold tint, slightly darker than that of the Cunucunuma bird. The yellow streaks on the back agree with those of the Cunucunuma bird, but there is no orange on the rump.

Our specimens seem to prove that *insperatus* ranges from southern Peru to Bolivia, east of the Beni and indicate that the locality attributed to the type of *bolivianus* is incorrect. Indeed, without a more definite data in regard to the Indian necklace to which as an ornament it was attached, one can not say where this type came from, but regardless of locality it is clearly more closely related to the Orinoco bird than to any other known form of this interesting group.

(1517) CAPITO VERSICOLOB (P. L. S. MULLET).

Bucco versicolor P. L. S. MÜLLER, Syst. Nat. Suppl., 1776, p. 88 ("Maynas"). Capito versicolor Berlepsch and Stolemann, Ornis, 1906, p. 98 (Idma).

Common in the Subtropical Zone at Idma. One male has the malar stripe largely yellow, in two others it is tinged with yellow, thus showing the approach to *C. glaucogularis* which was commented on at length by Berlepsch and Stolzmann in recording a specimen from Idma.³³ The malar stripe averages broader than in specimens from Bolivia.

Idma, 6 males, 3 females.

³⁵ Ornis, 1906, p. 98.

Family RAMPHASTIDAE. TOUCANS.

(1547) PTEROGLOSSUS CASTANOTIS CASTANOTIS Goold.

Pteroglossus castanotis Gould, Proc. Zool. Soc., 1833, p. 119 (Brazil).

The form found at the base of the Andes from Colombia to Bolivia is apparently to be referred to this race.

Rio Cosireni, 1 male, 2 females.

(1566) SELENIDERA LANGSDORFFI (Wagler).

Pteroglossus langedorffi WAGLER, Syst. Av., 1827, p. 12 (Brazil).

Rio Comberciato, 1 female.

(1578) AULACORHYNCHUS CAERULEOCINCTUS d'Orbigny.

Aulacorhynchus caeruleocinctus d'Orbigny, Voy. Amer. Mér., 1834–47, p. 382, pl. 66, fig. 2 (Bolivia).

Inhabits the Subtropical Zone. Agreeing with Bolivian specimens-San Miguel Bridge, 2.

Order PICIFORMES.

Family BUCCONIDAE.

BUCCOS, PUFFBIRDS.

(1627) BUCCO CHACURU Vicillet.

Bucco chacuru Vibillot, Nouv. Dict. d'Hist. Nat., vol. 3, 1816, p. 239 (Paraguay).— Berlepsch and Stolemann, Ornis, 1906, p. 97 (Santa Ana.)

(1628) NYSTALUS STRIOLATUS (Pelsein).

Bucco striolatus Pelzeln, Sitz. Akad. Wien, vol. 20, 1856, p. 509 (Engenho do Cap Gama).

No specimens available for comparison.

Rio Comberciato, 1 female (oviduct contained egg with hard white shell, Sept. 25).

(1638) MALACOPTILA FULVIGULARIS FULVIGULARIS Scienter.

Malacoptila fulvigularis Sclater, Proc. Zool. Soc., 1853, p. 128 (Bolivia).— Berlepsch and Stolzmann, Ornis, 1906, p. 97 (Idma).

A female differs from Bolivian examples much as *M. f. melanopogon* Berlepsch and Stolzmann, of Garita del Sol, is said to. Nevertheless these authors state that three specimens from Idma are nearer to the Bolivian than to the central Peruvian form.

Near Machu Picchu, 1 female.

(1658) MONASA MORPHOEUS PERUANA Sciater.

Monasa peruana Schater, Proc. Zool. Soc., 1855, p. 194 (Chamicuros, Peru).

Differs from a Bahia specimen only in the smaller amount of white about the base of the bill.²⁴

Rio Cosireni, 1 female.

[≥] See also Hellmayr, Nov. Zool., vol. 12, p. 297.

Family PICIDAE.

WOODPECKERS, PICULETS.

(1662) COLAPTES PUNA Cabanis.

Colaptes puna Cabanis, Journ. für Ornith., 1883, p. 98 (Valle de Tauli, W. Peru).— Berlepsch and Stolzmann, Ornis, 1906, p. 104 (Vilcabamba).

Colaptes rupicola Solater and Salvin, Proc. Zool. Soc., 1869, p. 154 (Tungasuca; Tinta).

Specimens from Guaqui, at the southern end of Lake Titicaca are referable to *C. rupicola*, while a series from Tirapata all have the red nape of *C. puna*. These specimens indicate, therefore, the non-integradation of these representative species. I have no examples of *cinereicapillus*. Specimens from Junin are referable to *puna*.

Ollantaytambo (12-13,000 feet), 1 male (breeding, Nov. 7), 1 female; Chospiyoc, 1 juv.; La Raya, 4 males, 1 female, 1?

(1682) CHLORONERPES CHRYSOGASTER Berlepsch and Stolzmann.

Chloronerpes chrysogaster Berlepsch and Stolzmann, Proc. Zool. Soc., 1902, vol. 2, p. 32 (Garita del Sol, central Peru).

A specimen from Santo Domingo, in southeastern Peru, suggests the probability of the intergradation of this form with $C.\ r.\ canipileus$ of Bolivia. It is near the latter but in its deeper yellow color and less distinct bars of the abdomen it approaches chrysogaster. As Berlepsch and Stolzmann have already said, it is a singular fact that birds from Colombia, Venezuela, and Bolivia should more nearly resemble each other than do those from Bolivia and Peru. Other than a small difference in size, the Bolivian bird being larger with a longer bill, I am indeed unable to separate $C.\ r.\ meridensis$ from $C.\ r.\ canipileus$.

Lucma, 1 female (breeding, Aug. 18); San Miguel Bridge, 1 male.

(1783) VENILIORNIS HAEMATOSTIGMA HILARIS (Cabanis and Heine).

Campias hilaris Cabanis and Heine, Mus. Hein., vol. 4, pt. 2, 1863, p. 154 (Peru). Veniliornis haematostigma hilaris Berlepsch and Stolemann, Ornis, 1906, p. 96 (Santa Ana).

As Berlepsch has shown, Malherbe founded his Mesopicus haematostigma on Natterer's birds from Borba and Maribataños in Brazil to which, therefore, the name should be restricted, while hilaris, as above, is applicable to the Peruvian form. I have no Brazilian specimens, but these two birds from Peru differ from two specimens from the Province of Santa Cruz, Bolivia (which should more nearly resemble true haematostigma) in being more broadly barred with white below, the olive bars, therefore, being not only broader but darker, and they are more deeply colored above. I consequently follow Berlepsch in accepting hilaris as the name of the Peruvian form.

²⁸ Proc. Zool. Sec., 1902, p. 34.

In the light of this material two specimens from La Morelia, in eastern Colombia³⁶ may perhaps better be referred to V. h. orenocensis Berlepsch and Hartert which, on the basis of two specimens from the upper Orinoco, appears to be merely a small form of hilaris. Two adult males from Peru and Bolivia, both lack the "fulvous yellow" on the neck, whitish line under the eye and whitish ante-ocular spot, the absence of which is said to distinguish the Orinoco form. Unfortunately no specimens of ruficeps are available.

Rio Cosireni, 1 male; near Santa Ana, 1 female.

(1752) CELEUS GRAMMICUS (Matherbe).

Picus grammicus Malherbe, Mém. Soc. Roy. Liége, vol. 2, 1845, p. 69.

An adult male is referred to this species of which I have seen no authentic specimens. It is considerably darker than Malherbe's plate.

Rio Comberciato, male.

(1762) CAMPEPHILUS MELANOLEUCUS MELANOLEUCUS (Gmelin).

Picus melanoleucus GMELIN, Syst. Nat., vol. 1, 1788, p. 462 (Surinam).

Rio Cosireni, 1 male.

(1767) CNIPARCHUS HAEMATOGASTER HAEMATOGASTER (Tuchedi).

Picus haematogaster TSCHUDI, Arch. für Naturg., 1844, p. 302, pl. 25 (Peru). Campephilus haematogaster BERLEPSCH and STOLEMANN, Ornis, 1906, p. 96 (Idma).

(1770) CEOPHLOEUS LINEATUS LINEATUS (Linnacus).

Picus lineatus Linnabus, Syst. Nat., vol. 1, 1766, p. 174 (Cayenne).
Ceophloeus lineatus Berlepsch and Stolzmann, Ornis, 1906, p. 96 (Santa Ana).

(1788) PICUMNUS JELSKII Taczanowski.

Picumnus jelskii Taczanowski, Proc. Zool. Soc., 1882, p. 41, pl. 2, fig. 3 (Paltay pampa, Cen. Peru).

I have no material for comparison. San Miguel Bridge, 3 males, 2 females.

Order PASSERIFORMES.

Family HYLACTIDAE.

TAPACOLAS, ETC.

(1818) SCYTALOPUS ACUTIROSTRIS Technoli.

Scytalopus acutirostris Techudi, Arch. für Naturg., 1844, p. 282 (Peru).

While certain species of the genus Scytalopus differ from each other but slightly, they have, nevertheless, most extended ranges. S. niger, for example, ranges from Chile to Colombia (though there must be many breaks in its distribution); S. micropterus, with but slight change, from Bolivia to Colombia. Specimens for comparison have

⁸⁴ Bull. Amer. Mus. Nat. Hist., vol. 36, 1917, p. 353.

not always been available, and the same species has therefore received different names in various parts of its range. Misidentifications have been frequent, and no one appears to have had the material for a revision of the group. As a result, existing descriptions are contradictory, and in short the group is badly in need of revision. Some years ago, having access to the Lafresnaye types and possessing a large number of Colombian specimens, I attempted to treat 27 (of the northern members of the genus, but lack of authentic Peruvian specimens prevented the satisfactory identification of all my material and with specimens from Peru now before me this want is felt even more strongly. Examination of the descriptions of von Tschudi, Taczanowski, von Berlepsch, and others reveals confusing contradictions, and I find myself quite unable to reach satisfactory conclusions regarding the identity of two of our three species of this genus. The two birds here referred to S. acutirostris, do not agree with von Tschudi's description of that species, but do agree with a description by Taczanowski of a "Oiseau typique de Tschudi." 38 They are dark slate color, with the posterior parts of the body cinnamon-brown barred both above and below with blackish; the tail, which appears to afford one of the most diagnostic characters in the birds of this genus, is slate-gray in the male and tinged with brownish in the female, but without bars in either. The birds measure: Male, wing, 60; tail, 44; tarsus, 23.5; culmen, 12 mm. Female, wing, 58; tail, 39; tarsus, 24; culmen, 11.

Occobamba Valley (9,100 feet), 1 male, 1 female.

SCYTALOPUS, species.

Two specimens from Cedrobamba, in the humid Temperate Zone, and one from Limbani, in southeastern Peru, agree in general color and pattern with the birds above recorded, but are paler with a silvery sheen on the plumage of the anterior parts of the body, a faint suggestion of a gray postocular stripe, a brownish tail with the central feathers indistinctly barred with black. Were it not for the latter character, they might be referable to S. simonsi, which is described as similar to S. silvestris but lacking the white patch on the abdomen, and having a whitish eyebrow. Taczanowski, however, describes the adult of sylvestris (and my specimens are adult) as having the tail "brune noiratre." My specimens measure:

Place.	Sex.	Wing.	Tail.	Tarsus.	Culmen.
Cedrobamba	Female.	53	34 31	19.5 22 20.5	11 11 10. 5

[#] The Auk, vol. 32, 1915, pp. 406-423.

^{*} Orn. du Perou, vol. 1, p. 538.

(1825) SCYTALOPUS MICROPTERUS BOLIVIANUS Allen.

Scytalopus bolivianus Allen, Bull. Amer. Mus. Nat. Hist., vol. 2, 1889, p. 98 (Reyes, Bolivia).

Comparison of the type of this form with a large series from Colombia shows that it differs only in being smaller. The type is not sexed, but is apparently a male, being dark slate with a silvery white crownpatch, only the posterior parts of the body being brown. It measures: Wing, 50; tail, 34; tarsus, 22; culmen, 12 mm. An average Colombian male measures: Wing, 61; tail, 43; tarsus, 24; culmen, 13.5.

Idma, female juv.

Family FORMICARIIDAE.

ANT BIRDS.

(1878) THAMNOPHILUS MELANOCHROUS Sciater and Salvin.

Thannophilus melanochrous Schatter and Salvin, Proc. Zool. Soc., 1876, p. 18, pl. 3 (Huiro, Peru).—Berliefech and Stolemann, Ornis, 1906, p. 93 (Idma).

With the exception of one from Santa Ana, our specimens are from the Subtropical Zone. They are all essentially topotypical.

Santa Ana, 1 female; Idma, 4 males, 4 females; San Miguel Bridge, 6 males, 7 females; Torontoy, 3 males, 2 females.

(1912) THAMNOPHILUS RADIATUS SUBRADIATUS Beriepsch.

Themnophilus subradiatus Berlerson, Journ. für Ornith., 1887, p. 17 (Upper Amazonia).

Thannophilus radiatus Sclater and Salvin, Proc. Zool. Soc., 1876, p. 16 (Huiro; Maranura).

Thamnophilus nigricristatus subradiatus Berlepsch and Stolzmann, Ornis, 1906, p. 93 (Santa Ana).

I follow Berlepsch in referring Santa Ana specimens to this form and Ridgway in ranking subradiatus as a race of radiatus.

Santa Ana, 2 males, 1 female; Chauillay, 1 female; San Miguel Bridge, 1 male.

(1936) DYSITHAMNUS OLIVACEUS (Tuchudi).

Thamnophilus olivaceus TSCHUDI, Faun. Per., 1844, p. 174, pl. 11, fig. 1 (Central

Dysithamnus olivaceus Bernerson and Stolemann, Ornis, 1906, p. 93 (Santa Ana; Idma).

(1999) HERPSILOCHMUS MOTACILLOIDES Tuczanowski.

Herpsilochmus motacilloides Taczanowski, Proc. Zool. Soc., 1874, p. 186 (Maraynico).—Berlepsch and Stolzmann, Ornis, 1906, p. 94 (Idma).

Three specimens, collected and sexed by the writer, confirm Berlepsch's statement that Taczanowski described as a male either a young male or female. The sexual differences are clearly given by Berlepsch.** I have seen no other specimens.

Idma, 1 male, 2 females.



[♥] Proc. Zool. Soc., 1896, p. 381.

(2016a) MICRORHOPIAS BUFA BUFATER (Lafresnaye and d'Orbigny).

Thamnophilus rufater LAFRESNAYE and d'ORBIGNY, Syn. Av., 1837, vol. 1, p. 12 (Chiquitoseni, Bolivia).

Formicivora rufatra Sclater and Salvin, Proc. Zool. Soc., 1876, p. 16 (Maranura). Formicivora rufa rufatra Berlepsch and Stolzmann, Ornis, 1906, p. 94 (Santa Ana).

The males are less rufous above but of practically the same size as one from São Paulo.

Santa Ana, 1 male, 1 female; Chauillay Bridge, 1 male, 1 female.

(2028a) MICRORHOPIAS BICOLOR, subspecies.

An adult male is intermediate between quixensis and bicolor but is larger and with a much heavier bill than either. It doubtless represents an undescribed race.

Rio Comberciato, 1 male.

(2055) CERCOMACRA TYRANNINA APPROXIMANS Pelsola.

Cercomacra approximans Pelzelin, Orn. Bras., 1868, pp. 85, 158 (Engenho do Cap Gama).

Two immature specimens are provisionally referred to this form of which I have seen no authentic specimens.

Rio San Miguel (4,500 feet), 1.

(2179) GRALLARIA SORORIA Berlepsch and Steinmann.

Grallaria sororia Berlefson and Stolemann, Ornis, 1901, p. 194 (Idma, Peru); 1906, p. 94 (Idma).

(2192) GRALLARIA ERYTHROLEUCA Sciater.

Grallaria erythroleuca Sclater, Proc. Zool. Soc., 1873, p. 783 (Huasampilla, Peru).

These specimens are from near the type locality.

Occobamba Valley (9,100 feet), 3.

(2198) OROPEZUS RUFULA OBSCURA (Berlepsch and Stelamann).

Grallaria rufula obscura Berlepsch and Stolzmann, Proc. Zool. Soc., 1896, p. 385 (Maraynioc).

Traps which Heller set for small mammals proved effective in securing an excellent series of this form in the humid Temperate Zone. Berlepsch and Stolzmann based their description on a single specimen which was compared with an evidently inadequate series of true rufula. The latter race, as stated in my paper on Colombian Birds, ** shows much variation, having what might be termed fulvous and rufous phases. The latter is the rarer and is shown by only 2 of our 19 specimens from Colombia and Ecuador. Both are from near Bogotá where, however, the rufous phase is also represented. It was evidently with the fulvous phase that the comparison of obscura was made, since all our Peruvian specimens are much paler than rufous

[∞] Bull. Amer. Mus. Nat. Hist., vol. 36, 1917, p. 397.

specimens of rufula, in fact are intermediate in color between the two phases. They are more uniform in color than a series of 8 specimens from Ecuador, which in turn show less variation than our series of 11 specimens from Colombia. The latter includes examples from each of the three Andean ranges in that country, and it is possible that the variations which they exhibit may in part be racial, though before learning of the constancy shown by these Peruvian birds I had considered the variations shown in Colombian specimens to be wholly individual.

Above Machu Picchu (12,000 feet), 4; Occobamba Valley (9,100 feet), 4.

Family DENDROCOLAPTIDAE.

WOODHEWERS, OVENBIRDS.

(2230) GEOSITTA TENUIROSTRIS (d'Orbigny and Lafresnaye).

Certhilauda tenuirostris d'Orbigny and LAFRESNAYE, Syn. Av., vol. 1, 1837, p. 72 (Cochabamba, Bolivia).

Geositta tenuivostris Schatter and Salvin, Proc. Zool. Soc., 1869, p. 153 (Tinta; Tungasuca).

I have no topotypical specimens, but the specimens listed below, together with 8 from Tirapata and 2 from Puno, agree with 3 from northwestern Argentina (Tilcara and above Tafi del Valle).

La Raya, 3; Cuzco, 2; Occombamba Pass, 2; Huaracondo Canyon, 1.

(2252) UPUCERTHIA PALLIDA Taczanowski.

Upucerthia pallida Taczanowski, Proc. Zool. Soc., 1883, p. 71 (Junin, Peru).

A common species at Tirapata and La Raya. The only topotypical specimen which I have seen is in much worn plumage. It is darker above, and the rufous of the wings and tail is less bright than in the following specimens:

Ttica-Ttica, 1; La Raya, 1 male; 1 female; 1 %.

(2268) CINCLODES FUSCUS RIVULARIS (Cabanis).

Cillurus rivularis Cabanis, Journ. für Ornith., 1873, p. 319 (Maraynioc, Peru). Cinclodes fuscus Sclater and Salvin, Proc. Zool. Soc., 1869, p. 153 (Tungasuca).

Our specimens agree with one from Lake Junin which may be considered topotypical.

Idma Pampa (11,200 feet), 1 (Oct. 9, "breeding"); above Machu Picchu (12,000-14,000 feet), 2; Ollantaytambo, 1; Huaracondo Canyon, 2; Ttica-Ttica, 5; Cuzco, 1; La Raya, 6.

(2278) CINCLODES ATACAMENSIS (Philippi).

Upucerthia atacamensis Philippi, Arch. für Naturg., 1857, p. 263 (San Pedro de Atacama, Chile).

I have no topotypical material.

La Raya, 4; Pisac, 1; Calca, 1; Chospiyoc, 1.

2787-21-6

(2280) LOCHMIAS OBSCURATA Cabanis.

Lochmias obscurata Cabanis, Journ. für Ornith., 1873, p. 65 (Monterico, Peru). Lochmias sororia Berlepsch and Stolzmann, Otnis, 1906, p. 91 (Santa Ana).

It is probable that the specimen recorded by Berlepsch and Stolzmann came from the Subtropical Zone above Santa Ana.

(2287) SCHIZOEACA PALPEBRALIS Cabanis.

Schizoeaca palpebralis Cabanis, Journ. für Ornith., 1873, p. 319 (Maraynioc, Peru).

I have seen no topotypical specimens of this representative of S. ariseo-murina.

(Cedrobamba, 12,000 feet), 3; above Torontoy, 14,000 feet, 3.

(2295a) LEPTASTHENURA ANDICOLA PERUVIANA Chapman.

Leptasthenura andicola peruviana Charman, Bull. Amer. Mus. Nat. Hist., vol. 41, 1919, p. 327 (La Raya, Peru).

Subspecific characters.—Similar to Leptasthenura andicola andicola of Ecuador, but crown light cinnamon-rufous instead of dark hazel, the black margins much narrower, the malar region and throat whiter, the lores and auriculars more rufescent, the back more broadly streaked with white, the wing-coverts and tertials narrowly but distinctly margined with pale cinnamon-rufous, markings near and at the base of the inner wing quills pale cinnanon-rufous and more evident, tail longer. Wing, 74; tail, 95; culmen, 11 mm.

La Raya, 1. (2297) LEPTASTHENURA PILEATA Schater.

Leptasthenura pileata Sclater, Proc. Zool. Soc., 1881, p. 487 ("Lima"-Andes above Lima).

A specimen from timber line (14,000 feet) above Torontoy does not agree with Sclater's description, and Mr. Chubb, to whom I have submitted a photograph of our bird, writes that it differs from the type and other specimens in the British Museum in having the black and white pattern of the throat "coarser and more contrasting." Sclater's description reads "beneath cinereous, with white shaft-stripes more distinct on the throat and breast," while our bird has no shaft-stripes below and the strongly marked black and white throat and upper breast are sharply defined from the rest of the underparts. It doubtless represents a new form, but I hesitate to describe it without actual comparison with pileata.

Above Torontoy, 14,000 feet, 1 male.

(2307) SYNALLAXIS AZARAE AZARAE d'Orbigny.

Synallaxis azarae d'Orbigny, Voy. Amer. Mér., Ois., 1839-1847, p. 246 (Vallegrande, Bolivia).

Synallaxis griseiventris Berlepsch and Stolzmann, Ornis, 1906, p. 91 (Idma).

Inhabits the Subtropical Zone. Our specimens agree with the type of Synallaxis griseiventris Allen,¹¹ but the crown averages deeper in color.

Idma, 3; San Miguel Bridge, 8; Torontoy, 6.

⁴ Said by Hellmayr to be synonymous with azarae. see Berlepsch, Proc. IV Int. Orn. Cong., 1907, p. 363.

(2318) SYNALLAXIS HYPOSPODIA Sciator?

Synallaxis hypospodia Sclater, Proc. Zool. Soc., 1874, p. 10 (Bahia).—Berlepsch and Stolzmann, Ornis, 1906, p. 92 (Santa Ana).

A single specimen agrees with one from Bahia, but the identification must be considered as provisional.

Santa Ana, 1.

(2373) SIPTORNIS ALBICAPILLA (Cabanis).4

Synallaxis albicapilla Cabanis, Journ. für Ornith., 1873, p. 319 (Maraynioc, Peru).

A male agrees with Cabanis's description. Cedrobamba, 1 male.

(2378a) SIPTORNIS MODESTA PRÒXIMA, new subspecies.

Subspecific characters.—Similar to Siptornis modesta sajamae Berlepsch, but upper parts darker, Saccardo's umber rather than buffy brown; band in wing darker; hazel instead of cinnamon-rufous; tail shorter.

Type.—Cat. No. 145,191, Amer. Mus. Nat. Hist., female adult, Ttica-Ttica, 11,500 feet, near Cuzco, Peru, July 2, 1916; F. M. Chapman.

Specimens examined.—Siptornis modesta proxima. Peru: Typelocality, 1 female (July 2); La Raya, 14,000 feet, 3 males, 1 female (April 5); Junin, 12,900 feet, 1 male (April 3). Siptornis modesta sajamae. Peru: Puno, 12,600 feet, 1 male, 1 female (Aug. 6, 2); Tirapata, 12,700 feet, 5 males, 8 females 1? (July 28-Aug. 3).

Remarks.—It is difficult to understand how so common, easily observed, and widely distributed a species as Siptornis modesta appears to be, at least in southern Peru, can have escaped previous observers. Possibly it has been recorded under some other name, but, if so, I have failed to find one that is applicable to it. It belongs in that section of the group having the rump and upper tail coverts uniform with the unstreaked back and all the retrices, including the outer pair, bicolored, and this excludes the possibility of its being referable to S. pudibunda, as that species is commonly described.

Mr. Charles Chubb has been kind enough to confirm my identification of Tirapata specimens as Siptornis modesta. They agree in color with examples from Puno which are doubtless referable to Siptornis modesta sajamae Berlepsch, of western Bolivia, but are nearer the form here described in size. Specimens from just beyond the divide at La Raya, might be expected to resemble those of Tirapata, distant only some 60 miles, and where apparently similar environmental conditions prevail; but, on the contrary, they agree

[⇔] See Hellmayr, Nov. Zool., 1914, p. 364.

Consult a recent revision of the genus "Siptornis," by Cory, Proc. Biol. Soc. Wash., vol. 32, 1919, pp. 149-160.

with the type and, what is more surprising, with an example from Junin, distant 450 miles. The differences between the two forms are slight, but their apparent significance and obvious bearing on the origin of the life of the Titicacan Basin impels their recognition by name.

Measurements.

Place.	Sex.	Wing.	Tail.
Bolivia (ex Berlepsch) ¹ . Puno, Titicaca ¹ . La Raya ² . Junin ² . Bolivia (ex Berlepsch) ¹ . Puno, Titicaca ¹ . Ttica-Ttica ² . La Raya ² .	do do Female. do	71 69 68 67–68 67	75–76 76 66 65 71–73 68 60

¹ Siptornis modesta sajamae.

(2385) SIPTORNIS OTTONIS Berlepsch.

Siptornis ottonis Berlepsch, Proc. Third Int. Cong., 1901, p. 197 (Cuzco, Peru). Huaracondo Canyon, 1; Cuzco, 1.

(2397) SIPTORNIS GRAMINICOLA (Sciater).

Synallaxis graminicola Sclater, Proc. Zool. Soc., 1874, p. 446, pl. 58, fig. 2 (Junin, Peru).

More richly colored below than a specimen in worn plumage from Oroya.

Ttica-Ttica, 2.

(2401a) SIPTORNIS URUBAMBENSIS Chapman.

Siptornis urubambensis CHAPMAN, Bull. Amer. Mus. Nat. Hist., vol. 41, 1919, p. 328 (above Machu Picchu (14,000 feet), Peru).

Specific characters.—Size of Siptornis flammulata to which it bears a general resemblance in the color of the underparts, but upperparts Prout's brown, the streaks obscure ochraceous-buff and extending little, if any, posterior to the nape; tail uniform, of about the same color as the back, without rufous.

Inhabits the Temperate Zone.

Above Machu Picchu, 14,000 feet, 2; 12,000 feet, 3.

(2409) PSEUDOCOLAPTES BOISSONNEAUTI AURITUS (Techudi).

Anabates auritus Tschudi, Arch. für Naturg., 1844, p. 294 (Peru).

Distinguished from Colombian and Ecuadorian examples chiefly by its yellow-tinged throat and cheek-tufts. Inhabits the Subtropical Zone.

Torontoy, 3.

³ Siptornis modesta prozima.

(2420a) PHACELLODOMUS STRIATICEPS GRISEIPECTUS Chapman.

Phacellodomus striaticeps griscipectus CHAPMAN, Proc. Biol. Soc. Wash., vol. 32, 1919, p. 258 (Ttica-Ttica, near Cuzco, Peru).

Subspecific characters.—Throat and breast grayish vinaceous-buff, instead of being essentially pure white; flanks and abdominal region much deeper, the former nearly ochraceous-tawny; ear coverts and sides of the neck grayer, less cinnamon-rufous; upper parts averaging darker, with less cinnamon-rufous, especially anteriorly.

Ttica-Ttica, 5; Calca, 2; Cuzco, 5; Anta, 1; La Raya, 1; Huaracondo Canyon, 1.

(2478) THRIPADECTES SCRUTATOR Taczanowski.

Thripadectes scrutator TACZANOWSKI, Proc. Zool. Soc., 1874, p. 137 (Maraynioc, Peru).

I have no material for comparison.

Lucma (8,000 feet), 1.

(2493) XENOPS RUTILUS HETERURUS Cabanis and Heine.

Xenops heterurus Cabanis and Heine, Mus. Hein., vol. 2, 1859, p. 33 (Colombia). Xenops rutilus heterurus Berlepsch and Stolzmann, Ornis, 1906, p. 92 (Idma).

These specimens are slightly smaller than Colombian examples, but essentially agree with them in color. Found in the Subtropical Zone. Idma, 2; San Miguel Bridge, 3; Rio San Miguel, 1.

(2508) MARGARORNIS PERLATA (Lesson).

Sittasomus perlatus Lesson, Echo du Monde Sav., Aug. 11, 1844, col. 275 (Bogotá-El Piñon, above Fusugasugá, altitude 9,600 feet).

? Margarornis perlata peruviana Corr, Field Mus. Pub., No. 167, 1913, p. 291 (Tambo Ventija, 10 miles east of Molinopampa, Peru).

Found in the Temperate Zone. These specimens have the throat and spots of the under surface more yellow than in most specimens of true perlata, but they can be matched by at least half a dozen specimens in a series of perlata from Colombia. I find no difference in the coloration of the upper parts of adults from the two countries.

Cedrobamba (12,000 feet), 3; above Torontoy (14,000 feet), 2.

(2511) PREMNORNIS GUTTATA (Lawrence).

Margarornis guttata LAWRENCE, Ann. Lyc. New York, vol. 8, 1867, p. 128 (Quito).

This specimen can be matched by one from near Bogotá, which I have referred to *guttata* on the basis of the agreement of an immature Colombian specimen, from San Antonio, with Lawrence's type, which is also immature.

Idma, 1.

(2589) THRIPOBROTUS WARSCEWICZI WARSCEWICZI Cabanis and Heine.

Thripobrotus warscewiczi Cabanis and Heine, Mus. Hein., vol. 2, 1859, p. 39 (Peru).

Picolaptes lacrymiger warszewiczi Berlepsch and Stolzmann, Ornis, 1906, p. 92 (Idma).

On comparison of this specimen with one from Molinopampa, northern Peru, Mr. C. B. Cory writes that he considers it "to be nearly or quite typical of warscewiczi."

San Miguel Bridge, 1.

(2594) THRIPOBROTUS FUSCICAPILLUS Peizela.

Picolaptes fuscicapillus Pelzelin, Orn. Bras., vol. 1, 1868, p. 63 (Engheno do Gama, Matto Grosso, Brazil).

After comparing specimens from southeastern Peru with the type of fuscicapillus, Hellmayr 14 refers them to that species. Three specimens, one each from Todos Santos, Province Cochabamba, Bolivia, Astillero, southeastern Peru, and Rio Cosireni, agree, and, in view of Hellmayr's conclusions, are doubtless inseparable from fuscicapillus. This species has also been recorded from the Chanchamayo district by Berlepsch and Stolzmann, 15 and from Sarayacu, Ecuador by Sclater, 16 but the last-named specimen requires redetermination.

Rio Cosireni, 1.

Family TYRANNIDAE.

TYRANT FLYCATCHERS.

(2631) AGRIORNIS POLLENS Sciater.

Agriornis pollens Schater, Proc. Zool. Soc., 1869, p. 153 (Panza, Ecuador).

These specimens are somewhat smaller than two from Ecuador, and have the throat less heavily streaked. Neither of two males has the outer primary acuminate.

La Raya, 6.

(2633) AGRIORNIS SOLITARIA INSOLENS Sciator and Salvin.

Agriornis insolens Schatze and Salvin, Proc. Zool. Soc., 1869, p. 153 (Tinta, Peru).

Above Ollantaytambo (13,000 feet), 1; Ttica-Ttica, 2; La Raya, 4.

(2636) CNEMARCHUS ERYTHROPYGIUS (Sciator).

Taenioptera erythropygia Sclater, Proc. Zool. Soc., 1851, p. 193, pl. 41 (Ecuador). The breast and head are grayer than in two old Ecuador specimens. Cedrobamba (12,000 feet), 2.

⁴⁴ Verh. Orn. Gesell. Bayern, vol. 11, 1912, p. 161.

⁴⁶ Proc. Zool. Soc., 1896, p. 378.

⁴⁶ Cat. Birds. Brit. Mus., vol. 15, 1890, p. 154.

(2658a) OCHTHOECA FUMICOLOR BERLEPSCHI Hellmayr.

Ochthoeca fumicolor berlepschi Hellmayr, Nov. Zool., vol. 21, 1914, p. 167 (Malaga, w. Bolivia).

Ochthoeca oenanthoides AUTHORS.

Our specimens essentially agree with one from Limbani, southeastern Peru, and differ from O. f. brunneifrons as described by Hellmayr.

Above Machu Picchu (12,000 feet), 4.

(2656) OCHTHOECA OENANTHOIDES POLIONOTA Sciater and Salvin.

Ochthoeca polionota Schatter and Salvin, Proc. Zool. Soc., 1869, p. 599 (Pitumarca, S. Peru).

The type of this form, a male (No. 4821, Amer. Mus. Nat. Hist.), through exposure to light, is too much faded to be of value for color comparison. It measures, wing, 89.5 mm.; tail, 73 mm., and with this size virtually topotypical specimens from Cuzco and La Raya agree. Specimens from Tirapata, Limbani and Puno are intermediate in size between polionota and oenanthoides, but are nearer the former in color.

Cuzco, 1 male; La Raya, 3.

(2658) OCHTHOECA LEUCOPHRYS LEUCOMETOPA Sciater and Salvin.

Ochthocca leucometopa Sclater and Salvin, Proc. Zool. Soc., 1877, p. 19 (Cuzco, Peru).

Octhoeca leucophrys Sciater and Salvin, Proc. Zool. Soc., 1869, p. 154 (Tinta).

Specimens from Calca, Pisac and Ttica-Ttica may be considered topotypical. Immature birds show to some extent the rufous wingbars which characterize true leucophrus.

Ollantaytambo, 4; Huaracondo Canyon, 7; Chospiyoc, 1; Calca, 2, Pisac, 4; Ttica-Ttica, 3; Cuzco, 7.

(2664) OCHTHOECA FRONTALIS SPODIONOTA Berlopsch and Stolzmann.

Ochthoeca spodionota Berlepsch and Stolzmann, Proc. Zool. Soc., 1896, p. 356 (Maraynioc, Peru).

In spite of the fact that Berlepsch and Stolzmann after seeing Sclater and Salvin's type of O. pulchella from Bolivia, consider their spodionota inseparable, I find that an adult male from Machu Picchu is certainly not the same as two specimens from the trail to Santo Domingo in southeastern Peru. These birds have the superciliary yellow (less strong posteriorly), whereas in the Machu Picchu bird it is snowy white, only the portion before the eye being yellow. I have seen no specimens from Maraynioc, but the close faunal affinity of that locality with the humid Temperate Zone of the Urubamba region makes it more than probable that our specimen should be referred to spodionota.

Above Machu Picchu (12,000 feet), 1.

[#] Proc. Zool. Soc., 1902, vol. 2, p. 57.

(2647a) OCHTHOECA LESSONI TECTRICIALIS, new subspecies.

Subspecific characters.—Underparts as in Ochthocca rufipectoralis (d'Orbigny and Lafresnaye); upper parts more like those of O. lessoni Iessoni Sclater, but back browner, head darker, greater coverts very narrowly, instead of broadly, tipped with rich cinnamon-rufous or hazel; inner wing-quills very faintly if at all margined with this color.

Type.—No. 145244, Amer. Mus. Nat. Hist., male adult, Huaracondo Canyon (altitude 10,000 feet), July 23, 1916; Geo. K. Cherrie.

Material examined.—Ochthoeca lessoni tectricialis. Peru: Type locality, 1 male, 1 female; above Machu Picchu (12,000 feet), 1 male, 1 female; above Torontoy (10,700-14,000 feet), 2 males. Ochthoeca lessoni lessoni. Colombia: 11 males, 6 females. Ecuador: Pichincha, 1; "Ambato," 1. Ochthoeca rufipectoralis. Bolivia: Incachaca, Prov. Cochabamba, 3 males, 5 females.

Remarks.—The form of Ochthoeca lessoni inhabiting southern Peru is an obvious intermediate between O. lessoni lessoni of Colombia and O. rufpectoralis of Bolivia. It is, however, nearer to the former and apparently does not intergrade with the latter, in which the wing-bars are wholly absent and the back is of nearly the same color as the crown, while in tectricialis, as in true lessoni, the back is decidedly browner than the crown and the greater coverts are definitely (if narrowly) tipped with cinnamon-rufous.

The proposed new form has the same deeply colored breast as in rufipectoralis, and, as in that species, this color more nearly reaches the base of the bill than in lessoni, in which the chin is gray.

(2670) OCHTHOECA THORACICA Tacsanowski.

Ochthoeca thoracica Taczanowski, Proc. Zool. Soc., 1874, p. 133 (Chilpes, Peru). Above Torontoy (9,500-10,700 feet), 3.

(2678) MECOCERCULUS LEUCOPHRYS SETOPHAGOIDES (Boneparte).

Tyrannula setophagoides Bonaparte, Atti Sesta Riun. Sci. Ital., Milan, 1845, p. 405 (Bogotá).

Averaging slightly paler above but essentially agreeing with a large series from Colombia, showing no approach, therefore, to the Bolivian race. Specimens from Venezuela (near Mérida and Las Palmales in the Carúpano region) have the wing bars and margins to secondaries much paler, and in this respect are nearer to leucophrys than to setophagoides. They may stand as M. leucophrys nigriceps Chapman.

Above Machu Picchu (12,000 feet), 3; above Torontoy (14,000 feet), 5.

(2680) MECOCERCULUS STICTOPTERUS TAENIOPTERUS Cabania,

Mecocerculus taeniopterus Cabanis, Journ. für Ornith., 1874, p. 98 (Peru).

Mecocerculus stictopterus euplastus Oberholser, Proc. U. S. Nat. Mus., 1903, p. 63 (Maraynioc, Peru). See Berlepsch, Ornis, vol. 14, 1907, p. 489.

Found in the humid Temperate Zone. Identified on the basis of comparison with specimens from the Temperate Zone in Ecuador and Colombia.

Above Torontoy (10,700 feet), 2; Occobamba Valley, 1.

(2689a) MECOCERCULUS SUBTROPICALIS Chapman.

Mecocerculus subtropicolis Chapman, Proc. Biol. Soc. Wash., vol. 32, 1919, p. 262 (San Miguel Bridge, Urubamba Canyon, Peru).

Specific characters.—Similar to Mecocerculus stictopterus taeniopterus Cabanis, but back greener, cap grayer and less sharply defined from nape, wing coverts whiter and broader, ear coverts grayer, superciliary less extended posteriorly, abdominal region more yellow; size smaller.

An apparently distinct species of the Subtropical Zone. San Miguel Bridge, 4; Idma, 3.

(2682) MECOCERCULUS POECILOCERCUS (Sciater and Salvin).

Serpophaga poecilocercus Sclater and Salvin, Nom. Av., 1873, p. 158 (Puellaro, Ecuador).

Agrees with Ecuadorian and Colombian specimens. San Miguel Bridge, 1.

(2700) KNIPOLEGUS HETEROGYNA OCKENDENI Hartert.

Knipolegus aterrimus ockendeni Hartert, Bull. Brit. Orn. Club, vol. 23, 1908, p. 11 (Carabaya, Peru).

Our specimens agree with topotypical examples and differ from true aterrimus as described, and also in the lack of rufous in the wing of the female. In view of the close faunal affinities of the Subtropical Zone of southeastern Peru with that of Bolivia, the differences between the Peruvian and Bolivian forms of this bird seem to be of specific value. It is evident, however, on comparison with topotypes of heterogyna from Cajabamba, that the Peruvian forms are subspecifically related.

San Miguel Bridge, 5 males, 3 females; Torontoy, 5 males, 2 females.

(2718) MUSCISAXICOLA ALBIFRONS (Technol).

Ptyonura albifrons TSCHUDI, Faun. Per., Aves, p. 167, pl. 12, fig. 2 (Peru).

Muscisaxicola albifrons Berlepsch and Stolzmann, Ornis, 1906, p. 103

(Vilcabamba).

La Raya, 3.

(2720) MUSCISAXICOLA GRISEA Toczanowski.

Muscisaxicola grisea Taczanowski, Orn. Pérou, vol. 2, 1884, p. 213 (Maraynioc, Peru).

Agrees with the original description. Above Ollantaytambo (13,000 feet), 1.

(2729) MUSCISAXICOLA ALBILORA Lafresnaye.

Muscisaricola albilora LAFRESNAYE, Rev. et Mag. Zool., 1855, p. 60. (Type locality by subsequent designation "vicinity of Santiago, Chile.")

We have specimens of albitora, rufivertex, and a third unidentified species, all taken at Cuchacancha, Bolivia, in June, indicating the specific distinctness of these forms. One specimen each from Machu Picchu and Limbani, Peru, and from Cuchacancha, Bolivia, agree. I have seen none from Lake Junin.

Above Machu Picchu (14,000 feet), 1.

(2730) MUSCISAXICOLA RUFIVERTEX d'Orbigny and Lafresnaye.

Muscisaricola rufivertex d'Orbigny and Lafresnaye, Syn. Av., pt. 1, 1837, p 66 (Cobija, Bolivia [=Chile],).—Sclater and Salvin, Proc. Zool. Soc., 1869, p. 154 (Tinta).

Muscisazicola occipitalis Ridgway, Bull. U. S. Nat. Mus., vol. 10, 1887, p. 430 (Lake Titicaca).

These specimens agree closely with about an equal number from Cuchacancha (11,000 feet), near Cochabamba, Bolivia, and also two from the Titicaca district. One of the latter, and another from near Cuzco, have the under tail coverts tinged with rufous, a character attributed to *M. r. ruficrissa* Cory. I have seen no specimens from Cobija, "Bolivia" [=coast of Chile].

La Raya, 6; Calca, 1; Ttica-Ttica, 3; above Ollantaytambo (12,500 ft.), 1.

(2733) MUSCISAXICOLA MACULIROSTRIS d'Orbigny and Lafresnaye.

Muscisaxicola maculirostris d'Orbigny and Lafresnaye, Syn. Av., pt. 1, 1837, p. 66 (La Paz, Bolivia).—Sclater and Salvin, Proc. Zool. Soc., 1869. p. 154 (Tinta).

I detect no variation in a large series from Peru, Bolivia, and northern Chile.

Huaracondo Canyon, 2; Pisac, 2; Cuzco, 1; Ttica-Ttica, 8.

(2735) MUSCISAXICOLA FLUVIATILIS Sciater and Salvin.

Muscisazicola fluviatilis Sclatze and Salvin, Proc. Zool. Soc., 1866, p. 187 (Lower Ucayli), 1876, p. 16 (Potrero).—Berlepsch and Stolzmann, Ornis 1906, p. 85 (Santa Ana; Idma).

The presence of a species of this Temperate Zone genus in the Tropical Zone presents an exceptionally interesting problem in distribution.

Rio Comberciato, 1.

(2729) LESSONIA NIGER OREAS (Sciater and Salvin).

Centrites oreas SCLATER and SALVIN, Proc. Zool. Soc., 1869, p. 151 (Tinta, Peru).

Huaracondo Canyon, 1; Calca, 1; La Raya, 1.

(2778) TODIROSTRUM CINEREUM CINEREUM (Linnaeus).

Todus cinereus Linnaeus, Syst. Nat., vol. 1, 1766, p. 178 (Surinam).

Todirostrum cinereum Sclater and Salvin, Proc. Zool. Soc., 1876, p. 16 (Maranura; Potrero).

These specimens have somewhat more black on the head than those in a series from the lower Orinoco, but agree with them in other respects. They thus show no approach to the green-backed *T. c. coloreum* of southern Brazil. The white-throated *T. sclateri*, is evidently confined to the Pacific coast region.

Santa Ana, 6; Idma, 1; Chauillay, 1; San Miguel Bridge, 2.

(2802a) EUSCARTHMUS LEUCOGASTER Hellmayr.

Euscarthmus leucogaster Hellmayr, Nov. Zool., vol. 21, 1914, p. 169 (Carabaya, S. E. Peru).

Agreeing with Hellmayr's description.

Rio Comberciato, 1.

(2805a) EUSCARTHMUS MARGARITACEIVENTER RUFIPES (Tachudi).

Orchilus rufipes Tachudi, Faun. Per., 1845-7, p. 165. (Peru).

Euscarthmus wuchereri Schater and Salvin, Proc. Zool. Soc., 1876, p. 16 (Maranura).

Apparently to be referred to this form. I have no satisfactory material for comparison.

Santa Ana, 2.

(2813) EUSCARTHMUS PYRRHOPS Cabania.

Buscarthmus pyrrhops Cabanis, Journ. für Ornith., 1874, p. 98 (Tambopata, Peru).

Idma, 1.

(2820) CAENOTRICCUS RUFICEPS (Lafresnaye).

Muscicapa (Todirostrum) ruficepe LAFRESNAYE, Rev. Zool., 1843, p. 291 (Colombia).

An adult female has the head and throat somewhat paler than in Colombian specimens, but aside from this I am unable to find any difference between it and a Colombian series.

Cedrobamba, 1.

(2826) LOPHOTRICCUS SQUAMAECRISTATUS HYPOCHLORUS Berlepsch and Tacsanowski.

Lophotriccus squamicristatus hypochlorus Berlepscu and Stolzmann, Ofnis, 1906, p. 85 (Idma, Peru).

Lophotriccus equamaecristatus pileatus RIDGWAY (not Tschudi), Bull. U. S. Nat. Mus., No. 50, pt. 4, p. 371.

The characters on which this race are based are pronounced in specimens from Santo Domingo, southeastern Peru.

Idma, 3; Rio San Miguel (4,000 feet), 1.

See Berlepsch and Stolsmann, Proc. Zool. Soc., 1896, p. 860.

(2829) ORCHILUS ECAUDATUS (d'Orbigny and Lafressaye).

Toduostrum ecaudatum d'Orbigny and Lafresnaye, Syn. Av., pt. 1, 1837, p. 47 (Yuracares, Bolivia).

Found in the Tropical Zone. Compared with two Bolivian specimens (Rio Chimoré) the two birds listed below have the crown-cap larger, the superciliary more apparent, the sides with less greenish yellow. These differences may in part be due to the make-up of the skins.

Rio Cosireni, 2.

(2840) PHYLLOSCARTES VENTRALIS ANGUSTIROSTRIS (Lafresnaye and d'Orbigny).

Muscicapa angustirostris LAFRESNAYE and d'Orbigny, Syn. Av., pt. 1, 1837, p. 52 (Yungas, Bolivia). See von Berlepsch, Ornis, vol. 14, 1907, p. 486. Leptopogon tristis Sclater and Salvin, Proc. Zool. Soc., 1876, p. 254 (Simacu, Bolivia).

On the basis of descriptions only, I refer to this species the specimens listed below, one from Santo Domingo, southeastern Peru, and two from Incachaca, Bolivia. The San Miguel Bridge birds have slightly less yellow on the throat, and the upperparts are somewhat duller with the crown less bright than the back. These birds are barely separable subspecifically from Leptopogon flavovirens Lawrence, of which we have the type, but in default of authentic specimens of true ventralis I make no further comment on their relationship.

San Miguel Bridge, 3.

(2847) MYIOSYMPOTES ACUTIPENNIS (Sciater and Salvin).

Hapalocercus acutipennis Sclater and Salvin, Proc. Zool. Soc., 1873, p. 137 (Bogotá).—Berlepch and Stolemann, Ornis, 1906, p. 86 (Idma).

This species ranges from the Tropical to the Temperate Zone without apparent variation. I have only a female from Colombia.

Rio San Miguel, 2; Santa Ana, 2; Idma, 2; San Miguel Bridge, 3; Calca, 1.

(2843) OREOTRICCUS PLUMBEICEPS (LAWRENCE).

Pogonotriccus plumbeiceps LAWRENCE, Ann. Lyc. Nat. Hist. New York, vol. 9, 1870, p. 267 (Bogotá).

Compared with four specimens from Colombia, these Peruvian birds have the throat more extensively gray, the breast more olive.

Idma, 4. (2871) SERPOPHAGA CINEREA CINEREA (Strickland).

Euscarthmus cinerea STRICKLAND, Ann. Mag. Nat. Hist., vol. 13, 1844, p. 414 (Chile-Bolivia).

Ranges from the Tropical to the Temperate Zones. Specimens from the upper zone, however, are slightly larger than those from the lower.

Idma, 1; San Miguel Bridge, 5; Chospiyoc, 2; Calca, 3; Pisac, 1.

(2880) ANAERETES PARULUS AEQUATORIALIS Berlepsch and Taczanowski.

Anaeretes parulus aequatorialis Berlepsch and Taczanowski, Proc. Zool. Soc., 1884, p. 296 (Cechce, W. Ecuador).

There is remarkably little variation in this species, it being possible to match specimens from Chile with others from Ecuador. When, however, comparable series are examined, it appears that birds from Colombia, Ecuador, and Peru have the crest less developed and not so black, the back averaging browner, the forehead and nape less streaked with white, the orbital and auricular region less black. In the Urubamba Valley this bird was found chiefly in the Subtropical Zone; in Colombia it reaches the Temperate Zone.

San Miguel Bridge, 2; Torontoy, 4; Occobamba Valley, 3; Machu Picchu, 1.

(2884) ANAERETES FLAVIROSTRIS Science and Salvin.

Anaeretes flavirostris Sclater and Salvin, Proc., Zool. Soc., 1876, p. 355 (Tilotilo, Bolivia).

This is apparently a Temperate Zone representative of Anaeretes parulus. Our specimens agree with others from Bolivia.

Ollantaytambo, 2; Huaracondo Canyon, 3; Calca, 1; Pisac, 1; Cuzco, 6.
(2885a) ANAERETES AGRAPHIA Chapman.

Anaeretes agraphia Charman, Proc. Biol. Soc. Wash., vol. 32, 1919, p. 263 (Idma, 9,000 feet, near Santa Ana, Peru).

Specific characters.—Quite unlike any described species of the genus, but most nearly resembling Anaeretes agilis Sclater, from which it differs in having no streaks above or below, the crest wholly black, etc.

Known only from the type, taken by Heller above Idma, at an altitude of 9,000 feet. This is probably, like A. agilis, a species of the Temperate Zone.

(2888a) MIONECTES STRIATICOLLIS POLIOCEPHALUS Techudi.

Mionectes poliocephalus TSCHUDI, Faun. Per., 1845-46, p. 148, pl. 9, fig. 1 (Peru, "tiefern Waldregion").

Inhabits the Subtropical Zone. Differs from a topotypical series of true striaticollis of Bolivia, in having the white streaks of the throat less extended on to the breast; the sides and flanks less heavily streaked, the center of the belly somewhat deeper yellow and with fewer streaks; the plumbeous of the head more sharply defined, particularly on the sides of the neck, from the olive-green behind it. The Peruvian bird is intermediate between the Bolivian and Colombian forms, but differs sufficiently from both to be recognizable.

Idma, 6; San Miguel Bridge, 3.

(2896) LEPTOPOGON SUPERCILIARIS SUPERCILIARIS Technoli.

Leptopogon superciliaris TSCHUDI, Arch. für Naturg., 1844, vol. 1, p. 275 (Cen. Peru).—Berlepsch and Stolemann, Ornis, 1906, p. 86 (Idma).

Our specimens are less yellow below than Colombian specimens of poliocephalus; have the plumbeous cap more restricted, the wing-coverts less ochraceous. The differences are carried to the extreme in a series from Locotal, Bolivia, which, however, may well stand with the Peruvian race.

Idma, 4.

(2898) LEPTOPOGON RUFIPECTUS Taczanowski.

Leptopogon rufipectus Taczanowski, Orn. Pérou, vol 2, 1884, p. 249 (Ropaybamba. Peru).

Agreeing with Taczanowski's description. Evidently related to L. erythrops, but the front is blackish and the throat and breast olive tinged with ochraceous.

Idma, 1; San Miguel Bridge, 4.

(2930) TYRANNISCUS CINEREICEPS (Sciator).

Tyrannulus cinereiceps Sclater, Proc. Zool. Soc., 1860, p. 69 (Pallatanga, Ecuador).

Agreeing with specimens from Santa Elena and below Salento, Colombia.

Idma, 1; San Miguel Bridge, 1.

(2996a) TYRANNISCUS BOLIVIANUS VIRIDISSIMUS Sciater.

Tyranniscus viridissimus Sclater, Proc. Zool. Soc., 1873, p. 782 (Cosnipata. S. Peru).

Tyranniscus bolivianus Berlepsch and Stolzmann, Ornis, 1906, p. 86 (Idma).

Found in the Subtropical Zone. Easily distinguishable from T. b. bolivianus by its much yellower coloration, particularly of the underparts.

Idma, 5.

(2938) ELAENIA PLAVOGASTER FLAVOGASTER (Thumberg).

Pipra flavogaster Thunberg, Mém. Acad. St. Petersb., vol. 8, 1822, p. 286 (Brazil). Elainea pagana Sclater and Salvin, Proc. Zool. Soc., 1876, p. 16 (Maranura). Elaenea flavogaster Berlepsch and Stolzmann, Ornis, 1906, p. 86 (Santa Ana).

An abundant species of the Tropical Zone. Santa Ana, 10; Idma, 1.

(2942) ELAENIA GIGAS Sciater.

Elainea gigas Sclater, Proc. Zool. Soc., 1870, p. 831 (Napo).

Agree essentially with Zamora, Ecuador, specimens. Idma, 2.

(2944) ELAENIA CRISTATA Pelsein.

Elainea cristata Pelzeln, Orn. Bras., 1869, pp. 107, 177 (Goiaz, Brazil).—Berlepsch and Stolzmann, Ornis, 1906, p. 86 (Santa Ana).

(2949) ELAENIA ALBICEPS MODESTA Tschudi.

Elaenia modesta Tschudi, Archiv für Naturg., 1844, vol. 1, p. 274 (W. Peru). Eluinea albiceps Sclatze and Salvin, Proc. Zool. Soc., 1876, p. 16 (Huiro; Maranura; Potrero).

Elaenia albiceps modesta? Berlepsch and Stolzmann, Ornis, 1906, p. 87 (Idma).

As von Berlepsch has remarked ¹⁰, it is uncertain whether albiceps is represented in Peru by one or more races. It is my present opinion that there is more than one race, but in expectation of the receipt of additional material I defer an attempt to determine the Peruvian status of this species. Meanwhile, I refer specimens from the Subtropical Zone to this race, which I assume is typically represented in our collections by a series from near Lima. The Temperate Zone form is evidently separable.

San Miguel Bridge, 5; Occobamba Valley (9,100 feet), 1; Torontoy, 1.

(2349a) ELAENIA ALBICEPS, new subspecies.

Specimens from the Temperate Zone evidently represent a zonal form of this species, but I await the receipt of additional material before presenting a definite conclusion in regard to their status.

Chospiyoc, 3; Pisac, 7 (2 juv.).

(2968) ELAENIA PALLATANGAE Scinter.

Elainea pallatangae Sclater, Proc. Zool. Soc., 1861, p. 407, pl. 41 (Pallatanga, Ecuador).

Von Berlepsch refers specimens from Marcapata, southern Peru, to this species. I have no topotypical material.

Torontoy, 1.

(2958) ELAENIA OBSCURA OBSCURA (Lafressaye and d'Orbigny).

Muscipeta obscura Lauresnave and d'Orbigny, Syn. Av., pt. 1, 1837, p. 48 (Yungas, Bolivia).

Elainea obscura Sclater and Salvin, Proc. Zool. Soc., 1876, p. 16 (Huiro).

Agrees with two topotypical specimens. San Miguel Bridge, 1.

(2965) MYIOPAGIS VIRIDICATA, subspecies.

Elaenia viridicata Berlepsch and Stolzmann, Ornis, 1906, p. 87 (Santa Ana). Elainea placens Sclater and Salvin, Proc. Zool. Soc., 1876, p. 16 (Maranura).

A single specimen, in poor condition, does not admit of satisfactory identification.

Idma, 1.



Ornis, vol. 24, 1907, p. 406.

(2979) SUBLEGATUS PASCIATUS (Thumberg).

Pipra fasciata Thunberg, Mém. Acad. Imp. Sci. St. Petersb., vol. 8, pp. 283, 285 (Brazil).

Sublegatus griseocularis Sclater and Salvin, Proc. Zool. Soc., 1876, p. 16 (Maranura).

Sublegatus fasciatus Berlepsch and Stolzmann, Ornis, 1906, p. 87 (Santa Ana).

Found in the Tropical Zone.

Santa Ana, 5.

(2981) MYIOZETETES CAYENNENSIS (Lineacus).

Muscicapa cayennensis Linnaeus, Syst. Nat., vol. 1, 1766, p. 327 (Cayenne).

Myiozetetes cayennensis Sclater and Salvin, Proc. Zool. Soc., 1876, p. 16 (Huiro).

(2984) MYIOZETETES SIMILIS CONNIVENS Berlepsch and Stolsmann.

Myiozetetes similis connivens Berlepsch and Stolzmann, Ornis, 1906, p. 87, (Santa Ana, Peru).

Agree, on the whole, with eastern Colombia specimens, but are smaller.

Idma, 3.

(2990) CONOPIAS CINCHONETI (Technoli).

Tyrannus cinchoneti Tschudi, Faun. Pérou, 1844-45, p. 151, pl. 8, fig. 2 (Peru).

Colombian specimens are considerably smaller than this male from Peru, and if the difference proves to be constant it may warrant their subspecific separation.

Idma, 1.

(3007) MYIODYNASTES CHRYSOCEPHALUS CHRYSOCEPHALUS (Tschadi).

Scaphorhynchus chrysocephalus TSCHUDI, Arch. für Naturg., 1844, vol. 1, p. 272 (Peru).

Myiodynastes chrysocephalus Sclater and Salvin, Proc. Zool. Soc., 1876, p. 16 (Huiro).—Berlepson and Stolzmann, Orbis, 1906, p. 88 (Idma).

Inhabits the Subtropical Zone.

San Miguel Bridge, 5.

(3013) HIRUNDINEA SCLATERI Reinhardt.

Hirundinea sclateri Reinhardt, Fuglef. Bras. Camp., 1870, p. 147 (Peru).—Beelepsch and Stolzmann, Ornis, 1906, p. 89 (Pacaymayo).

A rather rare inhabitant of the barren canyon sides in the Subtropical Zone.

Colpani, 1 male; Paltaybamba (5,000 feet), 1 male.

(3022) MYIOBIUS CINNAMOMEUS CINNAMOMEUS (d'Orbigny and Lafresnaye).

Muscipeta cinnamomea d'Orbigny and Lafresnaye, Syn. Av., pt. 1, 1837, p. 49 (Yungas, Bolivia).

Myiobius cinnamomeus Berlepsch and Stolzmann, Ornis, 1906, p. 89 (Idma).

Common in the Subtropical Zone. I have seen no Bolivian specimens.

Idma, 2; San Miguel Bridge, 10; Torontoy, 1.

(2041) MYIOBIUS FASCIATUS SATURATUS Beriepsch and Stoizmann.

Myiobius nasvius saturatus BERLEPSCH and STOLEMANN, Ornis, 1906, p. 88 (Chirimoto; Santa Ana, Peru).

Myiobius naevius Schater and Salvin, Proc. Zool. Soc., 1876, p. 16 (Potrero).

Common in the Tropical Zone, ranging upward to the lower border of the Subtropical. Some of the specimens listed below can be matched by others from Colombia.

Santa Ana, 7; San Miguel Bridge, 3.

(3065) MYIOBIUS OCHRACEIVENTER (Cabanis).

Mitrephanes ochraceiventer Cabanis, Journ. für Ornith., 1873, p. 320 (Tilotile, Bolivia).

Myiobius subochraceus Schater, Proc. Zool. Soc., 1887, p. 50 (Tilotilo, Bolivia).

Identified from descriptions. As Sclater remarked, the generic affinities of this species appear to be with *Myiobius pulcher*. It is certainly not referable to *Mitrephanes*. The adult male has an orange-flame crest as in *M. flavicans* and *M. pulcher*.

Idma (9,000 feet), 1 male adult.

(3052) EMPIDOCHANES PORCILURUS PERUANUS Beriepech and Steizmann.

Empidochanes poecilurus peruanus Berlefson and Stolzmann, Proc. Zool. Soc., 1896, p. 366 (Garita del Sol, Peru).

On comparison with Colombian specimens, a female exhibits the characters ascribed to this race.

San Miguel Bridge, 1.

(3056) MITREPHANES OLIVACEUS Berlegech and Stolumana.

Mitrephanes olivaceus Berlepsch and Stolemann, Ibis, 1894, p. 891 (Garita del Sol, Peru).

Found in the Subtropical Zone. I have no specimens for comparison, but the species is said to range from central Peru to Bolivia, and Idma is within the heart of this region.

Idma, 2.

(3058) SAYORNIS NIGRICANS LATIROSTRIS (Cabaule and Helne).

Autonax latirostris Cabanis and Heine, Mus. Hein., vol. 2, 1859, p. 68 (Bolivia). Sayornis nigricans cineracea Authors (not Lafresnaye). See Bangs and Penard, Bull. Mus. Comp. Zool., 1919, p. 28.

Sayornis cineracea angustirostris Beelepson and Taczanowski, Proc. Zool. Soc., 1896, p. 357 (La Merced, Peru); Ornis, 1906, p. 85 (Santa Ana).

In specimens from Colombia and Venezuela, the wing and tail average shorter, the bill larger than in those from Peru and Bolivia; but I can detect no diagnostic difference in color which would separate northern from southern birds, and consequently would apply the name given to the Bolivian bird to all South American specimens of Sayornis nigricans.

San Miguel Bridge, 4.

2787-21-7

Measurements of males.

Locality.		Tail.	Bill from nostril.	
Yungas, Province of Cochabamba, Bolivia. Rio Inambari, Peru. San Miguel Bridge, Peru. Andalucia, Colombia. Rio Toché, Colombia. Near Mérida, Venezuela. Bermudez, Venezuela.	91 93 89 88. 5 88. 5	79 79 79 77 76. 5 77	11 11 11 12 11.5	

(3064a) EMPIDONAX TRAILLI ALNORUM Brewster.

Empidonaz trailli alnorum Brewster, Auk, 1895, p. 161 (Upton, Maine).

? Empidonax pusillus trailli Berlepsch and Stolemann, Ornis, 1906, p. 90 (Santa Ana, male Dec.).

Berlepsch and Stolzmann were uncertain whether to refer a single specimen in worn plumage to the eastern or western form of this species, and I am in the same position regarding a specimen from Cuzco. Ridgway records alnorum from Ecuador.

Cuzco, 1 (Nov. 30).

(3069) MYIOCHANES ARDOSIACUS ARDOSIACUS (Lafresnaye).

Tyrannula ardosiaca LAPREMATE, Rev. Zool., 1844, p. 80 (Oolombia).

Inhabits the Subtropical Zone. There is a slight lightening on the abdominal region which apparently indicates an approach to *M. a. plebius*.

San Miguel Bridge, 4; Torontoy, 1.

(3084) MYIARCHUS TYRANNULUS CHLOREPISCIUS Beriepsch and Leverhühn.

Myiarchus tyrannulus chlorepiscius Berlepsch and Leveretten, Ornis, vol. 6, 1890, p. 16 (Cuyaba, Brazil).

Myiarchus crythrocercus Sclater and Salvin, Proc. Zool. Soc., 1876, p. 16 (Maranura).

Myiarchus mexicanus chlorepiscius Berlepsch and Stolzmann, Ornis, 1906, p. 89 (Santa Ana).

Berlepsch refers a specimen from Santa Ana to this race, but a single bird in our collection from the same locality is much grayer than any one of a large series from Chapada, Matto Grosso.

Santa Ana, 1.

(3088) MYLARCHUS CEPHALOTES Taccanowski,

Myiarchus esphalotes TACZANOWSKI, Proc. Zool. Soc., 1879, p. 671 (Tambillo Peru).

Two specimens apparently represent this species of which my only other Peruvian specimen (from Province of Huanaco) is in much worn plumage. Colombian specimens referred to this species ⁵⁰ have the outer vane of the outer tail feather much paler than in these three Peruvian examples.

Chauillay, 1; Rio San Miguel (4,500 feet), 1.

(3089) MYIARCHUS PELZELNI Berlepsch.

Myjarchus pelzelni Berlepsch, Ibis, 1883, p. 139 (Bahia).—Berlepsch and Stolemann, Ornis, 1906, p. 89 (Santa Ana).

(3094) MYIARCHUS ATRICEPS Cabania.

Myiarchus atriceps Cabanis, Journ. für Ornith., 1883, p. 215 (Tucuman, Argentina)

A male agrees with a specimen from Tucuman.

Torontoy, 1.

• (8168) TYRANNUS MELANCHOLICUS MELANCHOLICUS VIolliot.

Tyronnus melancholicus Vieillot, Nouv. Dict. d'Hist. Nat., vol. 35, 1819, p. 84 (Paraguay).—Sclater and Salvin, Proc. Zool. Soc., 1876, p. 16 (Huiro.—Berlepsch und Stolemann, Ornis, 1906, p. 90 (Idma).

Inhabits the Tropical Zone and ranges upward to the Subtropical. Rio Cosireni, 1; Idma, 2; San Miguel Bridge, 4.

Family PIPRIDAE.

MANAKINS.

(3119) PIPRA CHLOROMEROS Tschudi,

Pipra chloromeros Tschudi, Arch. für Naturg., 1844, vol. 1, p. 271 (Peru). Rio Cosireni, 1 female.

(3123) PIPRA LEUCOCILLA COMATA Berlepsch and Stolzmann.

Pipra leucocilla comata Berlepsch and Stolzmann, Ibis, 1894, p. 392 (Chanchamayo, Peru).

Two specimens confirm the characters on which this race is based. Idma, 2 males.

Family COTINGIDAE.

COTINGAS.

(3212) PLATYPSARIS AUDAX (Cabanis).

Hadroetomus audaz Cabanis, Journ. für Ornith., 1873, p. 68 (Monterico, Peru).— Berlepsch and Stolzmann, Ornis, 1906, p. 90 (Casinchibua, 6,400 feet).

A specimen in the plumage of the female labeled "male, testes not enlarged," by Chapman. I have seen no other examples.

Midway between Torontoy and San Miguel Bridge, 1 female.

[■] Bull. Amer. Mus. Nat. Hist., vol. 36, 1917, p. 476.

(\$218) PACHYRHAMPHUS VERSICOLOR VERSICOLOR (Hartlanb).

Vireo versicolor Hartlaub, Rev. Zool., 1848, p. 289 (Colombia).

Pachyrhamphus versicolor Berlepsch and Stolzmann, Ornis, 1906, p. 90 (Idma).

An adult male agrees with others from Colombia, but has the underparts with fewer bars.

San Miguel Bridge, 1 male.

(3270-3271) RUPICOLA PERUVIANA PERUVIANA Letham.

Rupicola peruviana LATHAM, Ind. Orn., 1790, vol. 2, p. 555, based on Le Coq-deroche de Perou of Buffon, vol. 4, p. 437; Pl. Enl., p. 745.

Rupicola saturata Cabanis and Heine, Mus. Hein., 1859, vol. 2, p. 99 (Bolivia).

Rupicola peruviana saturata BERLEPSCH and STOLZMANN, Ornis, 1906, p. 90 (Idma).

A common species in the Subtropical Zone at Idma, and also occurring in the Urubamba Canyon at Machu Picchu.

Further consideration of the subject leads me to believe that the view provisionally advanced in the Bulletin of the American Museum of Natural History in regard to the proper application of the name peruviana is the correct one, namely, that the bird figured by Buffon is the southern, not the northern form of this species in which, as his plate shows, the black, subapical portion of the tertials is covered by the overlapping feathers, their exposed portion being wholly gray. In the northern bird the gray of the tertials is so restricted that the subapical black area is visible beyond the tip of the overlying feather. In body color Buffon's plate is more nearly like the northern bird, but without regard to the possibility of the plate having faded in the century and a quarter since it was colored, the tertial character described is the more pronounced and definite of the two and apparently compels us to apply Latham's name to the Peruvian form having the exposed portion of these feathers wholly gray.

It may be argued that specimens of the cock-of-the-rock from northern rather than southern Peru would be more likely to find their way into the hands of naturalists. But it must be remembered that Cuzco was one of the earliest places settled by Europeans and it had, therefore, long been a gateway for products of the montaña when Buffon's plate was made. We should, therefore, I think, restrict our evidence to the actual base of Latham's name—that is, Buffon's plate—and that, in my opinion, as well as that of several other naturalists to whom I have shown it, depicts the bird of southern Peru and eastern Bolivia. If this view be correct, saturata Cabanis and Heine becomes a synonym of peruviana Latham. I have seen no specimens from other parts of Peru. Those from Zamora in southeastern Ecuador are referable to the Colombia form aurea. Berlepsch and Stolzmann ⁵² refer specimens from the Chanchamayo district to "peruana," but at that time the distinctness of the south Peruvian

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Ibis, 1896, p. 369.

form was not recognized, and it is not improbable that a re-examination will show the Chanchamayo bird to be nearer the southern than the northern form. In that event *peruviana* and *aurea* will be found to intergrade between Zamora and the Chanchamayo district.

Huiro, Lucumayo Valley (4,500 feet), 2 males; Idma, 4 males, 2 females; near San Miguel Bridge, 3 males.

(3302) HELIOCHERA RUBROCRISTATA (d'Orbigny and Lafresnaye).

Ampelia rubrocristata d'Orbigny and Lafresnaye, Syn. Av., pt. 1, 1837, p. 39 (Yungas, Bolivia).

Found in the forests of the humid Temperate Zone. I have seen no Bolivian specimens, but those listed below agree with a large series from Colombia.

Cedrebamba, 2; Occobamba Valley (9,100 feet), 1; Lucma (9,000 feet), 1.

(3315) CEPHALOPTERUS ORNATUS Geoffrey.

(sele) CERTADOR IMBOS CENTRICES GENERAL.

Cephalopterus ornatus Geoffeot., Ann. Mus., vol. 13, 1809, p. 238, pl. 17 (Brazil).

Agrees with a specimen from Buena Vista, Colombia. Rio Comberciato, male adult.

Family HIRUNDINIDAE.

SWALLOWS.

(3337) ATTICORA PASCIATA (Gmelin).

Hirundo fasciata Gmelin, Sys. Nat., vol. 1, 1789, p. 1022 (Cayenne).

Rio Cosireni, 1 immature.

(8828) OROCHELIDON MURINA (Cassin).

Petrochelidon murina Cassin, Proc. Acad. Nat. Sci. Phila., 1853, p. 370 (Ecuador).

Our specimens appear to be typical.

Ollantaytambo, 3; Macha Picchu (12,000 feet), 1; La Raya, 1.

(3339) OROCHELIDON ANDECOLA (Lafresnaye and d'Ortigny).

Hirundo andecola LAPRESNAYE and d'ORBIGNY, Syn. Av., pt. 1, 1837, p. 69 (La Paz, Bolivia).—? Hirundo andicola Schater and Salvin, Proc. Zool. Soc., 1869, p. 151 (Tinta).

Taken only on the divide at La Raya where we also found O. murina. We have not, however, taken the former north of this point nor the latter south of it; O. andecola was common at Tirapata. La Raya, 1.

so Since the above was written, I have received two adult males from Utcnyacu, in the Chanchamayo district, which satisfactorily settle the proper allocation of Latham's name. In a word, they practically agree with Buffon's plate; that is, in general tone of color they are near the Colombian and Ecuadorian bird, but in the pattern of the tertials they exactly resemble the form from southern Peru and Bolivia. The latter character is so much the more pronounced and definite of the two that these birds should unquestionably be grouped with the southern rather than the northern form and they thus confirm the view expressed above.

(3342) PYGOCHELIDON CYANOLEUCA (Viciliot).

Hirundo cyanoleuca Vibillor, Nouv. Dict. d'Hist. Nat., vol. 14, 1817, p. 509 Paraguay).

Atticora cyanoleuca Schater and Salvin, Proc. Zool. Soc., 1876, p. 16 (Maranura).

Abundant in the Subtropical Zone and, on the Pacific side, descending to sea level.

San Miguel Bridge, 4; Torontoy, 1.

(3344) ALOPOCHELIDON FUCATA (Temminck).

Hirundo fucata TEMMINCK, Pl. Col., vol. 4, 1823, pl. 161, fig. 1 (Brazil).

Agreeing with specimens from Chapada, Matto Grosso. This species does not appear to have been before recorded from Peru. Below San Miguel Bridge, 2.

(3347) STELGIDOPTERYX RUFICOLLIS RUFICOLLIS (Viciliot).

Hirundo ruficollis Vientior, Nouv. Dict. d'Hist. Nat., vol. 14, 1817, p. 523 (Brazil).

Agreeing with specimens from Rio and Bahia. Below San Miguel Bridge, 2.

Family TROGLODYTIDAE.

WRENS.

(\$385) ODONTORCHILUS BRANICKII BRANICKII (Taczanowski and Beriopech).

Odontorhynchus branickii Taczanowski and Berlepsch, Proc. Zool. Soc., 1885, p. 72, pl. 6, (Machay and Mapoto, Ecuador).

Two specimens agree with one from La Palma, Colombia, but have the crown somewhat deeper in color. This appears to be the second record of the species for Peru.

San Miguel Bridge, 2.

(3430) CISTOTHORUS PLATENSIS GRAMINICOLA Tacmnowski.

Cistothorus graminicola Taceanowski, Proc. Zool. Soc., 1874, p. 130 (Maraynioc, Peru).—Berlepsch and Stolemann, Ornis, 1906, p. 74 (Puna of Idma).

Identified on geographical grounds only, since I have not seen typical specimens. The interscapular region has more white than in aequatorialis.

Cedrobamba, 1 female.

(3438) TROGLODTTES MUSCULUS PUNA Berlepech and Steismann.

Troglodytes musculus puna Berlepsch and Stolemann, Proc. Zool. Soc., 1896, p. 329 (Ingapirca).

A common form of the arid Temperate and Puna Zones. Specimens from La Raya and from near Cuzco are more deeply colored than those from Ollantaytambo, which show in their paler underparts an approach to the Santa Ana form. Specimens from Toron-

toy are near the Santa Ana form in color, but are intermediate in size; the series, as a whole, showing complete intergradation between the Puna and Tropical Zone races.

Ollantaytambo, 4; Chospiyoc, 2; Huaracondo Canyon, 2; Pisac, 2; Calca, 2; Ttica-Ttica, 4; Cuzco, 4; La Raya, 3.

(8442) TROGLODYTES MUSCULUS AUDAX Tschudi.

Troglodytes audax TSCHUDI, Faun. Peruana, 1845-46, p. 185 (Coast of Peru; see Berlepsch and Hellmayr, Journ. für Ornith., 1905, p. 6).

Twelve specimens from Santa Ana and La Merced agree in size and in color. In the first-named character they are like a large series from the vicinity of Lima, but as might be expected, they average darker in color than Pacific coast specimens. The difference, however, is slight and is doubly bridged by individual variation. That is, specimens in the Santa Ana series are as light as the average Pacific coast bird, while others from near Lima are as dark as any of our Santa Ana or La Merced birds. In spite, therefore, of the striking differences which exist between the climate of the eastern and western bases of the Andes, and notwithstanding the fact that these regions are separated by a mountain range reaching to the Puna Zone, essentially the same form of House Wren occurs in both.

As remarked under the preceding race, specimens from San Miguel Bridge and Torontoy approach the Puna Zone race.

Santa Ana, 5; San Miguel Bridge, 1; Torontoy, 2.

(3451) TROGLODYTES SOLSTITIALIS MACROURUS Beriepech and Steismann.

Troglodytes solstitialis macrourus BERLEPSCH and STOLZMANN, Proc. Zool. Soc., 1902, vol. 2, p. 55 (Central Peru).

These specimens do not conform exactly to the description of this form, and comparison with topotypes will be required to determine whether they are typical.

Torontoy (9,500-10,700 feet). 2.

(3458) HENICORHINA LEUCOPHRYS LEUCOPHRYS (Tochudi).

Troglodytes leucophrys Tschudi, Arch. für Naturg., 1844, p. 282 (Peru). Henicorkina leucophrys Berlepsch and Stolzmann, Otnis, 1906, p. 74 (Idma).

Common in the Subtropical Zone.

Idma, 7; San Miguel Bridge, 8; Torontoy, 1.

Family CINCLIDAE.

DIPPERS.

(3480) CINCLUS LEUCOCEPHALUS Tochadi.

Cinclus leucocsphalus Teonudi, Arch. für Naturg., 1844, p. 279 (Peru).

Common in the Subtropical Zone.

San Miguel Bridge, 2.

Family TURDIDAE.

THRUSHES.

(3508) PLANESTICUS SERRANUS (Technol).

Turdus serranus Tschudi, Arch. für Naturg., 1844, vol. 1, p. 280 (Peru).—Beelepsch and Stolzmann, Ornis, 1906, p. 73 (Idma).

A female is apparently to be referred to this species. Torontoy (9,500 feet), 1 female.

(3511) PLANESTICUS LEUCOPS (Taczanowski).

Turdus leucops Taczanowski, Proc. Zool. Soc., 1877, p. 331 (Ropaybamba, Peru).

PLANESTICUS, species.

A female from San Miguel Bridge and an unsexed immature specimen from Idma represent a species of the *phaeopygus* group unknown to me. I trust that with the receipt of additional material I shall be able satisfactorily to determine their identity.

(3544) SEMIMERULA GIGAS GIGANTODES (Cabanis).

Turdus gigantodes Cabanis, Journ. für Ornith., 1873, p. 315 (Maraynioc, Peru).

A Temperate Zone species. I have seen no topotypical examples. Birds from northern Peru agree with those from the western and central Andes of Colombia, which I have identified, therefore, as gigantodes. The male listed below, however, is much blacker than my darkest Colombian specimens and is practically as dark below as above; in other words, it is an essentially black bird. The three females, moreover, are much paler, about the color of Colombian specimens. There is, therefore, apparently a sexual difference in the Peruvian birds not found in the Colombian form. Cabanis's description is based on a female, and it will consequently require comparison with specimens from Maraynioc to determine the identity of these south Peruvian birds.

Occobamba Valley, 9,100 feet, 1 male, 3 females.

(3548) SEMIMERULA CHIGUANCO (d'Orbigny and Lafresnaye).

Turdus chiquanco d'Orbigny and Lafresnaye, Syn. Av., pt. 1, 1837, p. 16 (Tacns, Chile).

This species is distributed from the Pacific coast to at least 14,000 feet, and in spite of this remarkable range it apparently shows no geographical variation.

San Miguel Bridge, 9; Torontoy, 2; Huaracondo Canyon, 1; Chospiyoc, 1; Ollantaytambo, 3; Pisac, 2; Calca, 3; Ttica-Ttica, 3; Cuzco, 1; La Raya, 1.

CATHABUS, species.

A female in juvenal plumage from the Occobamba Valley (9,100 feet) I am unable to identify.

⁸⁴ Bull. Amer. Mus. Nat. Hist., vol. 36, 1917, p. 537.

Family VIREONIDAE.

VIREOS.

(8563) VIREOSYLVA OLIVACEA (Linnacus).

Muscicapa olivacea Linnaeus, Syst. Nat., vol. 1, 1766, p. 327 (Cerolina).

Vireosylvia olivacea Solater and Salvin, Proc. Zool. Soc., 1876, p. 16 (Maranura; Huiro).

(3565) VIREOSYLVA CHIVI CHIVI (Vielliot).

Sylvia chivi Vielllot, Nouv. Dict. d'Hist. Nat., vol. 11, 1817, p. 174 (Paraguay). Viveo chivi Berlepsch and Stolemann, Ornis, 1906, p. 76 (Santa Ana).

Ranging from the Tropical to the Subtropical Zone. These specimens are considerably brighter than others from Sao Paulo and near Buenos Aires, but I have not material with which to settle their status satisfactorily.

Santa Ana, 2; Idma, 2; San Miguel Bridge, 7.

(3568) VIREOSYLVA JOSEPHAE JOSEPHAE (Sciator).

Vireo josephae Sclater, Proc. Zool. Soc., 1859, p. 137, pl. 154 (Pallatanga, Ecuador).—Berlepsch and Stolzmann, Ornis, 1906, p. 76 (Idma).

Inhabits the Subtropical Zone. These specimens agree with four from Ecuador.

Idma, 2; San Miguel Bridge, 6; Torontoy, 3.

Family MNIOTILTIDAE.

WOOD WARBLERS.

(3617) COMPSOTHLYPIS PITIAYUMI ELEGANS Todd.

Compectifypie piticyumi elegane Todd, Ann. Cara. Mus., vol. 8, 1912, p. 204 (Tara Mt., Ven.).

Parula pitiayumi Sclatee and Salvin, Proc. Zool. Soc., 1876, p. 16 (Huiro). Compsothlypis pitiayumi Berlepsch and Stolzmann, Ornis, 1986, p. 74 (Santa Ana).

Our specimens average slightly larger than those from east of Bogota, Colombia, but agree with them in color. This form appears, therefore, to range down the Amazonian slopes and base of the Andes from Venezuela to Peru. I have not the material to determine its distribution eastward in the forests of Amazona. Chapada, Matto Grosso specimens are referable to true pitiayumi.

Santa Ana, 1 male, 3 females; Idma, 1 female juv.; Chauillay, 1 %; San Miguel Bridge, 5 males, 1 female.

(3628) DENDROICA CAERULEA (Wilson).

Sylvia cerulea Wilson, Amer. Orn., vol. 2, 1810, p. 141, pl. 17, fig. 5 (Pennsylvania).

Dendroica rara Berlepsch and Stolzmann, Ornis, 1906, p. 74, Idma (1 male, Oct. 29).

(3639) GEOTHLYPES ARQUINOCITALIS CUCULLATA (Latham).

Sylvia cucullata Latham, Ind. Orn., vol. 2, 1790, p. 528 (no locality given; Brabourne and Chubb give "Brazil"; I suggest adding Rio Janeiro).

Geothlypis canicapilla assimilis Berletsch and Stolemann, Ornis, 1906, p. 75, Chirimoto, Peru; specimens from Santa Ana and Maranura).

Our specimens have smaller bills and longer tails than most examples from eastern Brazil, but resemble in size specimens from Chapada, Matto Grosso. I can find no diagnostic differences in color between our Peruvian birds, a large series from Chapada and seven adult males from São Paulo, Rio, and Bolivia, and consequently do not consider assimilis of Berlepsch and Stolzmann worthy of recognition. Idma, 2 females (Oct. 22, breeding); Santa Ana, 1 male, 2 females.

(3647) WILSONIA CANADENSIS (Linnaous).

Muscicapa canadensis Linnaeus, Syst. Nat., vol. 1, 1766, p. 327 (Canada). Sylvania canadensis Berlepsch and Stolzmann, Ornis, 1906, p. 76, Idma (1 female, July).

(3649) MYIOBORUS VERTICALIS (d'Orbigny and Lafresnaye).

Setophaga verticalis d'Orbigny and Lafresnaye, Syn. Av., pt. 1, 1837, p. 53 ("Ayupaya, Boliviana").—Sclater and Salvin, Proc. Zool. Soc., 1876, p. 16 (Huiro, Potrero).

Common in the Subtropical Zone. Peruvian and Bolivian specimens agree and have somewhat more white in the tail than Colombian specimens.

Idma, 2 males, 2 females; San Miguel Bridge, 3 males, 4 females, 1 %.

(3657) MYTOBORUS MELANOCEPHALUS MELANOCEPHALUS (Tschad).

Setophaga melanocephala Tschudi, Wieg. Arch., vol. 1, 1844, p. 276 (Peru).

Common in the Subtropical Zone. San Miguel Bridge, 7; Torontoy, 7.

(3663a) BASILEUTERUS LUTEOVIRIDIS SUPERCILIARIS Chapman.

Basileuterus luteoviridis superciliaris CHAPMAN, Proc. Biol. Soc. Wash., vol. 32, 1919, p. 265 (above Torontoy, 14,000 feet, Urubamba Canyon, Peru).

Subspecific characters.—Similar to Basileuterus luteoviridis luteoviridis (Bonaparte) of Colombia, but averaging slightly smaller, with a longer bill, rictal bristles more developed; the entire upper parts decidedly browner, the yellow superciliary much broader, brighter, in some specimens broader even than in "Myiothlypis" nigrocristatus, when it leaves an olive-green area on the crown about equal to the black area in the crown of that species. Differing from Basileuterus luteoviridis striaticeps Cabanis, and from B. l. signatus Berlepsch and Stolzmann, through the lack of even a trace of black on the forehead and crown, which is exactly concolor with the back; from specimens of signatus which lack black on the crown, it differs as it does from

true luteoviridie and, furthermore, in being larger; wing, 69.5; tail, 57; culmen, 12 mm.

Above Torontoy, 3; Cedrobamba, 1.

This form is apparently a Temperate Zone representative of Basileuterus luteoviridis signatus which occurs on the same mountains in the Subtropical Zone. Its zonal relations are presumably with "Myiothlypis" striaticeps from Maraynioc in the humid Temperate Zone east of the Junin region.

(3665) BASILEUTERUS LUTEOVIRIDIS SIGNATUS Beriepech and Stotzmann.

Basileuterus signatus Berlepsch and Stolzmann, Ornis, 1906, p. 74 (Idma, Peru).

Inhabits the Subtropical Zone. Having apparently but a single specimen from Peru and several from Bolivia, the describers of this race apparently either based their diagnosis chiefly on the Bolivian birds or else their Peruvian specimen was not representative. Twelve specimens from near the type locality in Peru and five from the same zone (Subtropical) in Bolivia, have the blackish forehead and lines on the side of the crown bordering the yellow superciliaries which form the principal characters of this race. It is shown in only two of the Peruvian birds, and then but faintly, while it is present in all five of the Bolivian birds. Should additional material confirm this difference it may be necessary to restrict the name signatus to the Peruvian bird which, aside from the character mentioned, is distinguished from true luteoviridis only by its smaller size, and give a new name to the Bolivian form. Four males from San Miguel Bridge measure: Wing, 59-61; tail, 54-60 mm.

I have not seen "Myiothlypis" euophrys Sclater and Salvin, of the same region in Bolivia whence come the specimens I have referred to signatus. It is evidently closely related to and perhaps identical with that form.

San Miguel Bridge, 4 males, 2 females; Torontoy, 2 males, 4 females.

(3669) BASILEUTERUS TRISTRIATUS (Techudi).

Myiodioctes tristriatus Tschudi, Arch. für Naturg., 1844, p. 283 (San Pedro, Peru). Inhabits the Subtropical Zone.

Idma, 4.

(3674) BASILEUTERUS CORONATUS (Technol).

Myiodiocies coronatus Tschudi, Arch. für Naturg., 1844, vol. 1, p. 283 (Peru). Basileuterus coronatus Berlepsch and Stolzmann, Ornis, 1906, p. 75 (Idma).

Inhabits the Subtropical Zone.

Idma, 4; San Miguel Bridge, 4; near Torontoy, 1.

Family MOTACILLIDAE. PIPITS, WAGTAILS.

(3694a) ANTHUS BOGOTENSIS IMMACULATUS Cory.

Anthus bogotensis immaculatus CORY, Field Mus. Pub., No. 190, 1916, p. 345 (mountains east of Balsas, Peru).

A female from La Raya and a male from Junin have the flanks practically unstreaked and should doubtless be referred to the form described from northern Peru by Cory. Five specimens from Bogotá all have the flanks conspicuously streaked.

La Raya, 1.

(3695) ANTHUS FURCATUS d'Orbigny and Lafresnaye.

Anthus furcatus d'Orbieny and Lafresnaye, Syn. Av., pt. 1, 1837, p. 27 (Patagonia).

In addition to the specimen from Ttica-Ttica, we have nine others from Tirapata. I have seen no topotypical examples.

Ttica-Ttica, 1.

Family FRINGILLIDAE.

FINCHES, SPARROWS, GROSBEAKS, Etc.

(3705) PHEUCTICUS CHRYSOCEPHALUS CHRYSOGASTER (Lesson).

Pitylus chrysogaster LESSON, Cent. Zool., 1830, pl. 67 (Chile).

Rio San Miguel, 4,500 feet, 1 female.

(3707a) PHEUCTICUS UROPYGIALIS TERMINALIS Chapman.

Pheucticus uropygialis terminalis CHAPMAN, Proc. Biol. Soc. Wash., vol. 32, 1919, p. 266 (San Miguel Bridge, Urubamba Canyon, Peru).

Subspecific characters.—In the comparative absence of black markings on the sides and flanks, and in the large size of the white endings of the greater wing coverts, resembling Pheucticus uropygialis meridensis Riley, of Venezuela; in the extent of yellow anteriorly on the bases of the feathers of the interscapulium nearer to meridensis than to Pheucticus uropygialis uropygialis Sclater, of Colombia; differing from both meridensis and true uropygialis in having large white terminal, or slightly subterminal, rounded spots on the upper tail coverts instead of small white or yellowish transverse subterminal marks on these feathers; lower tail coverts whiter; tibiae yellower.

San Miguel Bridge, 1; Chauillay, 1.

(3765) SPOROPHILA GUTTURALIS INCONSPICUA Berlepsch and Stolzmann.

Sporophila gutturalis inconspicua Berlepsch and Stolzmann, Ornis, 1906, p. 84 (Santa Ana, Peru).

Spermophila gutturalis Schater and Salvin, Proc. Zool. Soc., 1876, p. 16 (Maranura).

Inhabits the Tropical Zone. In the almost complete absence of black on the head, the males in our series resemble three birds from

the eastern base of the Colombian Andes to which I have before referred, but the throat and breast are darker and the dark area is more extensive in the Peruvian birds, which, in this respect, resemble specimens from the interior of Colombia. I have no Bahia examples.

Santa Ana, 3 males, 2 females; Idma, 1 male; San Miguel Bridge, 1 female.

(3778) SPOROPHILA OBSCURA (Taczanowski).

Spermophila obecura Taczanowski, Proc. Zool. Soc., 1874, p. 519 (Paltaypampa, Peru).

Sporophila obscura Berlepsch and Stolzmann, Ornis, 1906, p. 84 (Santa Ana).

An abundant inhabitant of the Tropical Zone, ranging upward to the lower border of the Subtropical Zone.

Rio Cosireni, 1; Santa Ana, 9; Idma, 3; Chauillay, 1; San Miguel Bridge, 5.

(3772) CATAMENIA INORNATA INORNATA (Lafrespaye).

Linaria inornata LAFRESNAYE, Rev. Zool., 1847, p. 75 (Bolivia).

These specimens agree in size with others from Oroya, Peru. I have seen none from Bolivia.

Ttica-Ttica, 1 male; above Machu Picchu, 12,000 feet, 1 female.
(3777a) CATAMENIA ANALOIDES GRISEIVENTRIS Chapman.

Catamenia analoides griseiventris CHAPMAN, Proc. Biol. Soc. Wash., vol. 32, 1919, p. 267 (Cuzco, Peru).

Catamenia analis Sclater and Salvin, Proc. Zool. Soc., 1869, p. 152 (Tinta).

Subspecific characters.—Male similar to male of Catamenia analoides analoides (Lafresnaye) of the Peruvian coast region, but abdominal region grayer, less white, the under parts, therefore, nearly uniform in color; second to sixth primaries (from without) with less white on their outer webs at base; lower tail coverts averaging paler and usually without the buffy tips which are always present in true analoides.

Cuzco, 1 male, 1 female; Pisac, 4 males, 2 females; Chospiyoc, 1; Huaracondo Canyon, 3; above Torontoy, 1.

A form of the arid Temperate Zone ranging from Southern Peru to Ecuador.

(3789) VOLATINIA JACARINI JACARINI (Linnacta).

Tanagra jacarini Linnabus, Syst. Nat., vol. 1, 1766, p. 314 ("Brasilia").

Santa Ana, 1 male.

(3803) SALTATOR MAXIMUS (P. L. S. Miller).

Tanagra maximus P. L. S. Müller, Syst. Nat., 1776, p. 159 (Cayenne).

Saltator magnus Sclatter and Salvin, Proc. Zool. Soc., 1876, p. 16 (Huiro).—

Berlepsch and Stolemann, Ornis, 1906, p. 88 (Santa Ana).

Peruvian and Bolivian specimens are smaller with smaller bills than those from British Guiana, but agree with them in color.

[#] Bull. Amer. Mus. Nat. Hist., vol. 26, 1917, p. 558.

(3800) SALTATOR CARRULESCENS AZARAE d'Orbigny.

Saltator azarae d'Orbigny, Voy. Amer. Mérid., Ois., 1836, p. 287 (Moxos and Santa Cruz, Bolivia).

Agrees with a specimen from the Falls of the Madeira. Santa Ana, 1.

(\$814) SALTATOR ALBOCILIARIS (Philippi and Landbock).

Pitylus albociliaris Philippi and Landbeck, Arch. für Naturg., 1863, p. 122 (Socoroma, "Peru" [=Chile]).

Saltator laticlavius Sclater and Salvin, Proc. Zool. Soc., 1869, p. 151 (Tinta).

Common in the arid Temperate Zone wherever there is scrubby tree growth.

Above Torontoy, 1; Ollantaytambo, 5; Huaracondo Canyon, 5; Chospiyoc, 2; Occobamba Valley, 1; Pisac, 6; Puquiura, 1; Cuzco, 1.

(3828) SPINUS ATRATUS (d'Orbigny and Lafresnaye).

Carduelis atrata d'Orbigny and LAFRESNAYE, Syn. Av., pt. 1, 1837, p. 83 (La Paz, Bolivia).

Chrysomitris atrata Sclater and Salvin, Proc. Zool. Soc., 1869, p. 152 (Pitumarca).

The yellow of the abdominal area is somewhat more extensive and, with other yellow areas, paler in color than in specimens from northern Argentina. I have none from Bolivia.

Ollantaytambo, 1 female; La Raya, 3 males, 3 females, 1%.

(3834) SPINUS ICTERICUS PERUANUS Berlepoch and Stolamann.

Spinus ictericus peruanus Berlepsch and Stolzmann, Proc. Zool. Soc., 1896, p. 352 (La Merced, Peru).

I have seen no specimens from La Merced, but have three from Oroya and one from Lima. The latter has the back brighter and under parts darker, and is smaller than the former. Possibly there is a littoral as well as an Andean race when the Oroya birds would doubtless be nearer true peruanus, although Berlepsch, with some reservations, refers Lima specimens to it.

Our series from 10,000 feet and upward in southern Peru agrees with the Oroya specimens, but two males from near San Miguel Bridge (4,500 and 6,000 feet), although they are like the remaining specimens in color, are considerably smaller (wing, 62 and 66 mm.). The Bolivian form, of which I have an excellent series, is distinguished by its paler coloration and greater extent of yellow on the tail rather than by the characters assigned to it by its describer.

San Miguel Bridge, 2 males; Chospiyoc, 2 males, 1 female; Ttica-Ttica, 1 male, 2 females; Cuzco, 3 males, 2 females; Pisac, 4 males; La Raya, 1 male, 1 female.

(3848) SYCALIS ARVENSIS (Kittlitz).

Fringilla arvensis Kittlitz, Mém. Acad. Imp. Sci. St. Petersb., 1835, vol. 2, p. 470 (Chile).

Huaracondo Canyon, 1 male.

(3856) MYOSPIZA AURIFRONS PERUANA (Beneparte).

Coturniculus peruanus Bonaparte, Consp. Av., vol. 1, 1850, p. 481 ("Am. m. occ.," I suggest, Santa Ana, Peru).

Myospiza peruana Berlepsch and Stolzmann, Ornis, 1906, p. 84 (Santa Ana).

Inhabits the Tropical Zone. There is an obvious and fairly constant difference separating birds from southern Peru and Bolivia from those of southeastern Ecuador (Zamora) and southeastern Colombia. The more southern birds have the dark centers of the feathers of the back smaller, and their margins much grayer, less olivaceous than the northern birds. These characters are not so noticeable in worn specimens but are usually diagnostic. The Zamora birds doubtless typically represent aurifrons aurifrons, and I assume that Bonaparte's name is applicable to the southern form. In addition to the Urubamba specimens listed below, we have examples of peruana from the following localities: Peru: Rio Inambari, 1; Rio Javari, 3; Astillero, 1; Candamo, 1; La Pampa, 2. Bolivia: Todos Santos, Province of Cochabamba, 1; Yungas, Province of Cochabamba, 2.

Rio Comberciato, 1; Idma, 1; Santa Ana, 1.

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(3843) POOSPIZOPSIS CAESAR (Scinter and Salvin).

Poospisa caesar Sclater and Salvin, Proc. Zool. Soc., 1869, p. 152, pl. 13 (Tinta, Peru).—Berlepsch and Stolzmann, Ornis, 1906, p. 103 (Curahussi).

Ollantaytambo, 1 male; Chospiyoc, 2 males; Huaracondo Canyon, 1 male, 1 †; Poquiura, 1 female; Pisac, 1 male; Calca, 1 male, 1 female; Cuzco, 1 male, 2 females; La Raya, 1 female.

(8882) BRACHYSPIZA CAPENSIS PERUVIANA (Lesson).

Pyrgita peruviana LESSON, Rev. Zool., 1839, p. 45 (Lima, Peru).

An abundant species ranging from the Pacific coast to the tableland, but on the eastern slope we did not take it below the Subtropical Zone. Our series appears to agree with specimens from Lima.

San Miguel Bridge, 3; Idma, 1; Torontoy, 1; Ollantaytambo, 2; Huaracondo Canyon, 2; Ttica-Ttica, 4; Cuzco, 6; Calca, 1; La Raya, 6.

(3968) PSEUDOCHLORIS OLIVASCENS CHLORIS (Technoli),

Sycalis chloris TSCHUDI, Faun. Per. Aves, 1846, p. 216.—SCLATER and SALVIN, Proc. Zool. Soc., 1869, p. 153 (Tinta).

Inhabits the Puna Zone. Specimens from Tirapata, taken in late July and early August, are completing the molt and are consequently in fresh plumage. A male which is evidently fully adult is bright olive-yellow above, the rump and upper tail coverts being nearly pure yellow. A second male has the back washed with brownish, but the upper tail coverts are nearly as bright as in the first-named male. A male from Pisac (April 18) is in worn plumage and differs so widely from either of the Tirapata birds that it is difficult to believe they represent the same species. While wear might change the back

of the immature Tirapata male to the dull greenish clive of that of the Pisac bird, it is difficult to understand how its bright yellow upper tail coverts could become as dull as they are in the male from Pisac. The latter closely resembles a male in comparable plumage from Bolivia labeled by von Berlepsch "olivascens," but is slightly smaller. (wing, 80 mm., tail, 53 mm., as compared with 87 mm., tail 54.5 mm.). Menegaux gives no measurements for the form from Pulcayo, Bolivia, for which he proposes the name Pseudochloris olivascens berlepschi, and I am therefore unable to consider it in this connection. However, if the Cuzco form be valid, the Pisac bird should be referred to it. The status of the Tirapata bird is not settled by the material at hand. Pisac, 1 male.

(3905a) PSEUDOCHLORIS UROPYGIALIS CONNECTENS Chapman.

Pseudochloris uropygialis connectens Chapman, Bull. Am. Mus. Nat. Hist., vol. 41, 1919, p. 329 (La Raya, Peru).

Subspecific characters.—Most nearly related to Pseudochloris uropygialis uropygialis (d'Orbigny and Lafresnaye) of Bolivia, but male with anterior portion of auriculars and, usually, region below the eye olive-yellow, yellow more extensive on sides and flanks; female with the whole head yellower than in Pseudochloris uropygialis uropygialis.

La Raya, 4 males, 3 females; Ttica-Ttica, 1 male.

(3918) PHRYGILUS GAYI PUNENSIS Ridgway.

Phrygilus punensis RIDGWAY, Proc. U. S. Nat. Mus., 1887, p. 434 (basin of Lake Titicaca in Peru and Bolivia).

Found in the open plains of the tableland. There is much variation in color in the specimens listed below. Some have the upper parts uniform olive-green, in others it is warm golden brownish. An adult from La Paz and another from Tirapata can be closely matched. Specimens from Oroya (-chloronotus Berlepsch and Stolzmann) also find their duplicates. I use the above combination of names without having determined the relationships of gayi and aldunatei.

La Raya, 8 males, 3 females; Cuzco, 10 males, 5 females; Huaracondo Canyon, 1 male.

(3922) PHRYGILUS FRUTICETI (Kittätz).

Fringilla fruticeti Krrrıxrz, Kupf. Vög., 1832, p. 18, pl. 23, fig. 1 (near Valparaiso, Chile).

Phrygilus frutiesti Sclater and Salvin, Proc. Zool. Soc., 1869, p. 152 (Tinta).— Berlepsch and Stolemann, Otnis, 1906, p. 103 (Curco; Luatanay).

Our series contains specimens in both worn (April) and fresh (October, November) plumage. They agree with others from near Santiago.

La Raya, 6 males, 1 female; Cuzco, 2 males; Pisac, 1 male; Huaracondo Canyon (11,000 feet), 1 male (breeding, Apr. 10).

[#] Rev. Franc. d'Orn., 1910, p. 194.

(3925) PHRYGILUS UNICOLOR UNICOLOR (d'Orbigny and Lafranaye).

Emberica unicolor d'Orbigny and LAFRESNAYE, Mag. de Zool., 1837, p. 79 (Cordillera of Tacora, Peru).

Taken only by Heller. I am surprised at our failure to secure this species at Tirapata or La Raya.

Occobamba Pass, above Ollantaytambo, 13,000 feet, 2 males; above Machu Picchu, 14,000 feet, 1 male, 1 female (breeding, June 5).

(3929) PHRYGILUS ALAUDINUS EXCELSUS Berlepsch.

Phrygilus alaudinus excelsus Berlepsch, Proc. Fourth Int. Cong., 1907, p. 351 (Vacas, Bolivia).

This is a very common bird at Tirapata, where we took 16 specimens in three days, but it was not found north of La Raya. Our specimens agree with a topotypical series from Bolivia, and comparison of both lots with Chilean material confirms the validity of this race.

La Raya, 3 males.

(1924) PHRYGILUS PLEBEJUS Technidi.

Phrygilus plebejus TSCHUDI, Arch. für Naturg., 1844, p. 290 (Peru).
Phrygilus plebejus Sclater and Salvin, Proc. Zool. Soc., 1869, p. 152 (Tinta).

An abundant species of the Puna Zone.

La Raya, 6 males, 5 females; Pisac, 1 male; Cuzco, 11 males, 6 females; Occobamba Pass, 13,000 feet, 1 male.

(3939) DIUCA SPECULIFERA (d'Orbigny and Lafresnaye).

Emberiza speculifera d'Orbigny and LAFRESNAYE, Mag. de Zool., Syn. Av., pt. 1, p. 78, 1837 ("in Bolivia, in summis Andibus").

I have seen no Bolivian specimens.

La Raya, 4 males.

(3941) CORYPHOSPINGUS CUCULLATUS (P. L. S. MWHer).

Fringilla cucullata P. L. S. Müller, Syst. Nat., vol. 1, 1776, p. 166 (Cayenne). Coryphospingus cristatus Sclater and Salvin, Proc. Zool. Soc., 1876, p. 16 (Potrero).

Coryphospingus cucullatus Berlepsch and Stolzmann, Ornis, 1906, p. 84 (Santa Ana; Pampa de Derrumbe; Idma).

Inhabits the Tropical Zone. Our specimens are somewhat paler than a male in worn plumage from Surinam loaned me by Mr. T. E. Penard.

Rio Cosireni, 2 males; Santa Ana, 1 male, 2 females; Chauillay, 1 male.

(3992a) ATLAPETES CANIGENIS Chapman.

Atlapetes canigenis Chapman, Bull. Amer. Mus. Nat. Hist., vol. 41, 1919, p. 330 (Torontoy, Urubamba Canyon, Peru).

Specific characters.—Most nearly resembling Atlapetes castaneifrons Sclater and Salvin, of Venezuela, but with no white malar stripe or black mystacal streak; anteorbital region grayish black

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Doubtless a species of the humid Temperate Zone.

Torontoy, 1 female; above Torontoy, 9,500 feet, 1 male (breeding, May 2), 1 female; Occobamba Valley, 1 female.

(4003) BUARREMON BRUNNEINUCHA (Lafresnaye).

Embernagra brunnei-nucha Lafresnaye, Rev. Zool., 1839, p. 97 (Mexico).

Buarremon brunneinuchus Berlepsch and Stolzmann, Ornis, 1906, p. 83 (Idma).

Not uncommon in the Subtropical Zone. Our specimens agree with others from Colombia.

Idma, 1 female (breeding, Oct. 25); San Miguel Bridge, 2 males, 3 females; Torontoy, 2 males, 1?.

Family COEREBIDAE.

HONEY CREEPERS.

(4027) DIGLOSSA SITTOIDES SITTOIDES (d'Orbigny and Lafresnaye).

Serrirostrum sittoides d'Orbieny and LAFRESNAYE, Syn. Av., pt. 2, 1838, p. 25 (Yungas, Vallegrande, Bolivia).

Diglossa sittoides Berlepsch and Stolemann, Ornis, 1906, p. 76 (Idma.).

Found in the Subtropical Zone. Our specimens agree with others from Bolivia.

Idma, 1 male; San Miguel Bridge, 4 males, 1 female.

(4030) DIGLOSSA BRUNNEIVENTRIS Lafresmaye.

Diglossa brunneiventris LAFRESHAYE, Rev. Zool., 1846, p. 318 (Peru).—Sclater and Salvin, Proc. Zool. Soc., 1869, p. 151 (Tinta).

A species of the Temperate Zone which, however, evidently ranges as low as 8,000 feet. It frequents the low bushy growths along water courses.

Cuzco, 4 males; Ttica-Ttica, 1 male, 1 female; Ollantayambo, 1 female; Torontoy, 8,000 feet, 1 male (breeding Nov. 2).

(4033a) DIGLOSSA MYSTACALIS ALBILINEA Chapman.

Diglossa mystacalis albilinea Chapman, Bull. Amer. Mus. Nat. Hist., vol. 41, 1919, p. 331 (Cedrobamba Ruins, Peru).

Subspecific characters.—Similar to Diglossa mystacalis mystacalis Lafresnaye of Bolivia, but with the mystacal stripe light ochraceous-buff or creamy white anteriorly, more ochraceous posteriorly, instead of "pale red" (from Lafresnaye and Sclater) or tawny; and consequently resembling in this character Diglossa pectoralis Cabanis.

Inhabits the humid Temperate Zone, where six specimens were secured by Heller. The species has not been recorded from Peru.

Cedrobamba, altitude 12,000 feet; timberline, 3 male adults (2 breeding, May 226); 1 female adult, 2 male juv.

(4041a) DIGLOSSA PERSONATA MELANOPIS Techudi.

Diglossa melanopis TECHUDI, Wiegm. Arch., 1844, p. 294 (Peru). Diglossa personata AUTHORS (Peruvian and Bolivian records).

Comparison of 4 specimens from Peru and 16 from Bolivia, with a very large series from Colombia, shows that this southern form, heretofore synonymized with true personata, may be recognized by its generally duller bluer color, especially on the wings, and by the absence of the conspicuous whitish edgings on the lower tail coverts present in all our adult Colombian examples.

As in Colombia, the species in Peru appears to range from the upper part of the Subtropical to the Temperate Zone.

Above Machu Picchu (12,000 feet), 1 male; Torontoy, 9,500 feet, 1 female; 14,000 feet, 1 male; Occobamba Valley, 9,100 feet, 1 male.

(4042) DIGLOSSA INDIGOTICA Sciater.

Diglossa indigotica Sclatze, Ann. Mag. Nat. Hist., 1856, p. 467 (Ecuador).

This species appears not to have been recorded from Peru, but the specimen listed below, together with 9 from Inca Mine, agree with one labeled as coming from Ecuador.

Rio San Miguel, 4,500 feet, 1 male (breeding, Oct. 5).

(4047) OREOMANES FRASERI Science.

Oreomanes fraseri Sclater, Proc. Zool. Soc., 1860, p. 75, pl. 159 (Panza, Ecuador).—
von Berlepsch, Ornis, vol. 11, 1900-01, p. 197 (Anta, Peru).—Hellmaye,
Verh. der Orn. Gesell. Bayern, vol. 11, 1912, p. 159 (Carabaya, Peru).

Oreomanes binghami Chapman, Bull. Amer. Mus. Nat. Hist., vol. 41, 1919,
p. 331.

A species of the Temperate Zone which is unknown between southern Peru and central Ecuador. An even more striking hiatus occurs in the recorded range of Diglossa brunneiventris which is unknown between central Peru and northern Colombia. Such gaps in distribution indicate lack of continuity in the Temperate Zone itself, and when the species found in these Temperate Zone islands show no appreciable differentiation, it seems evident that they have become isolated at a comparatively recent date. Specimens of Diglossa brunneiventris from Colombia, for example, are inseparable from others from Peru, and it now appears that the bird described by me as Oreomanes binghami is but the immature plumage of Oreomanes fraseri, Doctor Hellmayr writes me that an immature specimen in the collection of the Munich Museum is molting from the plumage of "binghami" to that of fraseri. The chin and malar stripe are white, but the superciliaries have acquired, through molt, the chestnut color of those of the adult.

Cedrobamba, 1 female.

(4050) CONIROSTRUM CYANEUM Taczanowski.

Conirostrum cyaneum Taczanowski, Proc. Zool. Soc., 1874, p. 512 (Sillapeta, Central Peru).

Occobamba Valley, 9,100 feet, 1 male, 1 female.

(4852) CONTROSTRUM PERRUGINETVENTRES Science.

Conirostrum ferrugmeiventris Sclater, Proc. Zool. Soc., 1855, p. 74, pl. 85 (Cachupata, Peru).

Above Torontoy (14,000 feet, timber line), 1 female.

(4054) CONIROSTRUM CINEREUM CINEREUM d'Orbigny and Lafresnaye.

Conirostrum cinereum d'Orbigny and Lafresnave, Syn. Av., pt. 2, 1838, p. 25 (Yungas, Bolivia).

Our specimens have not been compared with topotypical ones.

Occobamba Valley, 9,100 feet, 2 males; Ollantaytambo, 2 males, 1 female; Huaracondo Canyon, 1 male; Calca, 1 %; Cuzco, 2 males, 2 females.

(4057a) CONIROSTRUM ATROCYANEUM SORDIDUM Berlepsch.

Conirostrum atrocyaneum sordidum Berlepsch, Journ. für Ornith., 1901, p. 83 (western Bolivia).—Berlepsch and Stolzmann, Ornis, 1906, p. 76 (Idma).

Found in the Subtropical Zone. I have seen no specimens from Ecuador, but Lafresnaye describes his type as having the primaries margined with olivaceous, a character in which our Peruvian birds agree. Berlepsch refers Idma specimens to his *C. a. sordidum* of Bolivia, a form which appears to have been separated without comparison with topotypical material, and which is here provisionally recognized.

Idma, 5 males, 2 females; San Miguel Bridge, 3 males.

(4059) XENODACNIS PARINA Cabanis.

Xenodacnis parina Cabanis, Journ. für Ornith., 1873, p. 312, pl. 4, figs. 1, 2 (Maraynioc, Peru).

Found in the Temperate Zone. I have seen only the specimens recorded below.

Machu Picchu, above timber line, 13,000-14,000 feet, 2 males (breeding, June 11), 1 female; Idma Pampa, 11,200 feet, 1 male.

(4061) DACNIS CAYANA GLAUCOGULARIS Berlepsch and Stokmann.

Dacnis cayana glaucogularis Berlepsch and Stolzmann, Proc. Zool. Soc., 1896,
 p. 336 (La Gloria, Peru); Ornis, 1906, p. 77 (Idma).

Idma, 2 males, 2 females.

(4089-4091) IRIDOPHANES PULCHERRIMA PULCHERRIMA (Sciator).

Dacnis pulcherrima Sclater, Rev. Zool., 1853, p. 480 (Bogotá).

Chlorophanes pulcherrima stigmatura Berlepsch and Stolemann, Proc. Zool. Soc., 1896, p. 338 (Garita del Sol, central Peru); Ornis, 1906, p. 77 (Idma).

Found in the Subtropical Zone. None of our specimens exhibits the "grande tache blanche subterminale sur le barbe interne de la rectrice externe" attributed to this race. In several it is faintly suggested by a grayish area, but others are not distinguishable from males from Ecuador and Bogotá. It seems probable, therefore, that the quite distinct *I. p. aureinucha* Ridgway is restricted to the Pacific slope of the Ecuadorian Andes, while *I. p. pulcherrima* ranges from Colombia to southern Peru on the eastern slope of the range.

Idma, 5 males, 2 females.

Family TANAGRIDAE.

TANAGERS.

(4111) TANAGRA XANTHOGASTER (Sundevall).

Euphonia xanthogastra Sundevall, Svensk. vet. Akad. Handl., 1883, p. 310 (Brazil).—Berlepsch and Stolzmann, Ornis, 1906, p. 78 (Idma).

(4126) TANAGRA LANIIROSTRIS PERUVIANA (Beriepsch and Steizmann).

Euphonia lanifrostris peruviana Berlepsch and Stolemann, Ornis, 1906, p. 77 (La Merced; Santa Ana).

(4135) TANAGRA CHRYSOPASTA (Sciater and Salvin).

Euphonia chrysopasta Sclatze and Salvin, Proc. Zool. Soc., 1869, p. 438, pl. 30, figs. 1, 2 (R. Ucayali, Peru).

Rio Cosireni, 1 male, 1 female (breeding, Sept. 20).

(4149) PIPRAEIDEA MELANOTA VENEZUELENSIS Sciater.

Pipridea venezuelensis Sclater, Proc. Zool. Soc., 1856, p. 265 (Caracas, Venezuela). Pipridea melanota Berlepsch and Stolzmann, Ornis, 1906, p. 78 (Idma).

The two specimens listed below agree with others from Colombia. San Miguel Bridge, 1 male, 1 female.

(4155) TANGARA CHILENSIS (Vigors).

Aglaia chilensis Vigors, Proc. Zool. Soc., 1832, p. 3 (Chile-Bolivia. See Berlepsch, Rev. Tanag., 1910, p. 1026).

A species of the Tropical Zone. Peruvian specimens are larger than those from the Napo region.

Rio Cosireni, 2 males (breeding, Sept. 9, 11); Rio Comberciato, 1 male (breeding, Sept. 21).

(4163) TANGARA SCHRANKI (Spix).

Tanagra schranki Stix, Av. Bras., vol. 2, 1825, p. 38, pl. 51, fig. 1 (northern Brazi l See Berlepsch, Rev. Tanag., 1910, p. 1028).

A species of the Tropical Zone. Our specimens agree with others from Ecuador.

Rio Cosireni, 1 male, 1 female (breeding, Sept. 9, 11).

(4191) TANGARA GYROLOIDES CATHARINAE (Helimayr).

Calospiza gyroloides catharinae Hellmayr, Proc. Zool. Soc., 1911, p. 1106 (Chaquimayo, Carabaya, southeastern Peru).

Calospiza gyroloides Berlepsch and Stolzmann, Ornis, 1906, p. 78 (Idma).

(4204) TANGARA NIGROVIRIDIS BERLEPSCHI (Tacsanowski).

Calliste nigriviridis berlepschi Taczanowski, Orn. Pér., vol. 2, 1884, p. 469 (Auquimarca, Peru).

Calospisa nigriviridis berlepschi Berlepsch and Stolemann, Ornis, 1906, p. 78 (Idma).

This well-marked race was found in the forests of the Subtropical Zone.

Idma, 2 males, 1 female; Huadquiña, 1 male (breeding, Oct. 23).

(4208a) TANGARA CYANEICOLLIS GULARIS Chapman.

Tangara cyaneicollis gularis Chapman, Bull. Amer. Mus. Nat. Hist., vol. 41, 1919, p. 332 (Candamo, southeastern Peru).

Subspecific characters.—Most nearly related to Tangara cyaneicollis cyaneicollis, but male with head darker blue, of about the same shade as in T. c. caeruleocephala, but with no purple on the forehead and little if any on the throat.

Rio San Miguel (4,500 feet), 1 male, breeding October 2.

(4214) TANGARA FULVICERVIX (Sciator and Salvin).

Calliste fulricervix Schatter and Salvin, Proc. Zool. Soc., 1876, p. 354, pl. 30, fig. 1 (Bolivia).

Calospiza fulvicervix Berlepsch and Stolzmann, Ornis, 1906, p. 79 (Idma).

Abundant in the Subtropical Zone.

Idma, 18 males, 7 females; San Miguel Bridge, 1 male.

(4216) TANGARA MELANOTIS (Science).

Calliste melanotis Sclater, Ibis, 1876, p. 408, pl. 2, fig. 1 (Rio Napo, Ecuador). Calospiza melanotis Berlepsch and Stolemann, Ornis, 1906, p. 79 (Idma).

Found in the Subtropical Zone. Our specimens agree with one from Colombia.

Idma, 5 males; 3 females.

(4219) TANGARA PARZUDAKII (Lafresnaye).

Tanagra parzudakii LAFRESNAYE, Rev. Zool., 1843, p. 97 (Bogotá).

Calospiza parzudakii BERLEFSCH and STOLZMANN, Ornis, 1906, p. 79 (Idma).

? Tangara parzudakii florentes BANGS and NOBLE, The Auk, 1918, p. 459 (Charapi, northwestern Peru).

Inhabits the Subtropical Zone. Our series agrees closely in size and color with eight topotypical specimens of parzudakii. I have not seen T. p. florentes Bangs and Noble, based on a female from northern Peru. This bird is larger than any in our series, but in view of the practical identity of specimens from southern Peru and the type locality the validity of the proposed form seems questionable.

Idma, 7 males; 3 females.

(4222) TANGARA XANTHOCEPHALA XANTHOCEPHALA (Technol).

Calospisa xanthocephala Techudi, Arch. für Naturg., 1844, vol. 1, p. 285 (cen. Peru).—Berlepsch and Stolemann, Ornis, 1906, p. 79 (Idma).

Common in the Subtropical Zone.

Idma, 7 males, 3 females; San Miguel Bridge, 4 males, 1 female; Torontoy, 1 male.

(4224) TANGARA CHETSOTIS (Du Bus).

Calliste chrysotis Du Bus, Esq. Orn., pl. 7, 1845 (Peru).

Rio San Miguel, 4,500 feet, 1 male (breeding, Oct. 5).

(4228) TANGARA ABGENTEA ABGENTEA (Tochod).

Procnopis argentea TSCHUDI, Arch. für Naturg., 1844, vol. 1, p. 285 (Peru). Calcepiza argentea BERLEPSCH and STOLEMANN, Ornis, 1906, p. 79 (Idma).

Inhabits the Subtropical Zone.

Idma, 3 males (1 breeding Oct. 17), 1 female; San Miguel Bridge, 2 males, 2 females.

(4234) IRIDOSORNIS JELSKII JELSKII Cabanis.

Iridornis jelskii Cabanis, Journ. für Ornith., 1873, p. 316, pl. 5, fig. 1 (Maraynioc, Peru).

Above Machu Picchu (12,000 feet, timber line), 2 males, breeding May 22 and June 8.

(4237) IRIDOSORNIS ANALIS (Technoli).

Tanagra analis Твенирі, Arch. für Naturg., 1844, vol. 1, p. 287 (Peru). Idma, 2 males.

(4244) POECILOTHRAUPIS IGNIVENTRIS (d'Orbigny and Lafresnaye).

Aglaia igniventris d'Orbigny and LAFRESNAYE, Syn. Av., pt. 1, 1837, p. 32 (Aplobamba, Bolivia).

Inhabits the humid Temperate Zone. Although obviously representing *P. lunulata*, our specimens show no indication of intergrading with that species.

Above Machu Picchu (12,000 feet, timber line), 6 males (3 breeding, May 23-June 2), 1 female.

(4254) BUTHRAUPIS CUCULLATA SATURATA Beriepsch and Steismann.

Buthraupis cucullata saturata Berlepsch and Stolemann, Ornis, 1906, p. 80 (Idms, Peru).

Occobamba Valley, 9,100 feet, 1 male; Torontoy, 10,700 feet, 1 male.

(4269) DUBUSIA STICTOCEPHALA Berlepsch and Stokmann.

Dubusia stictocephala Berlerson and Stolemann, Ibis, 1894, p. 386 (Maraynioc, Peru).

Occobamba Valley (9,100 feet), 1 female.

(4273) THRAUPIS EPISCOPUS MAJOR (Beriepoch and Stelmans).

Tunagra coclessis major Berlersun and Stolzmann, Proc. Zool. Soc., 1896, p. 343 (La Merced, Peru); Ornis, 1906, p. 81 (Santa Ana).

Tanagra coelectis SCLATER and SALVIN, Proc. Zool. Soc., 1876, p. 16 (Huiro; Potrero).

Inhabits the arid Tropical Zone and ranges upward to the lower border of the Subtropical. The present form, coelestis and leucoptera are evidently representatives of one species. Several of our Peruvian specimens closely resemble others from the Bogotá region.

Santa Ana, 1 male, 1 female; Idma, 4 males, 1 female; Chauillay, 1 male; San Miguel Bridge, 2 males, 2 females.

(4281) THRAUPIS PALMARUM MELANOPTERA (Sciater).

Tanagra melanoptera Sclater, Proc. Zool. Soc., 1856, p. 235 (Eastern Peru). San Miguel Bridge, 1 female.

(4287) THRAUPIS DARWINI LAETA (Berlepsch and Stokmann).

T[anagra] darwini lasta Berlepsch and Stolemann, Ornis, vol. 13, 1906, p. 81 (Cuzco; Idma).

Tanagra darwini Sclater and Salvin, Proc. Zool. Soc., 1869, p. 151 (Tinta).

Specimens from Cuzco, Calca, and Pisac are topotypical. There appears to exist no clear understanding regarding the limits of the range of this form and *T. d. darwini*. I have seen no specimens of the latter.

San Miguel Bridge, 1 female; Machu Picchu, 1 female; Chospiyoc, 1 female (breeding, April 20); Calca, 3 males, 2 females; Pisac, 1 male; Cuzco, 1 male, 1 female.

(4288) SPOROTHRAUPIS CYANOCEPHALA CYANOCEPHALA (d'Orbigny and Lafresnaye).

Aglaia cyanocephala d'Orbigny and Lafresnaye, Syn. Av., pt. 1, 1837, p. 32 (Yungas, Bolivia).

Inhabits the Subtropical Zone. Our specimens average slightly smaller and more yellow than a topotypical series.

San Miguel Bridge, 3 males, 2 females; Torontoy, 1 male, 2 females; Occobamba Valley, 1 male.

(4298) RAMPHOCELUS CARBO CONNECTENS Beriepsch and Stolzmann.

Rhamphocelus jacapa connectens Berlepsch and Stolzmann, Proc. Zool. Soc., 1896, p. 344 (La Merced, Peru); Ornis, 1906, p. 81 (Santa Ana; Idma).

Ramphocoelus atrosericeus Sclater and Salvin, Proc. Zool. Soc., 1876, p. 16 (Maranura; Potrero).

Common in the Tropical Zone ranging upward to the lower border of the Subtropical.

Rio Comberciato, 1 male (breeding, Sept. 25); Santa Ana, 1 female; Idma, 5 males (2 breeding, Oct. 14, 17); 3 females (2 breeding, Oct. 14, 17).

(4807) PIRANGA RUBRA RUBRA (Liniasous).

Muscicapa rubra Linnaeus, Syst. Nat., vol. 1, 1758, p. 181 (Carolina).

Piranga rubra Berlepsch and Stolzmann, Ornis, 1906, p. 81 (Idma, 2 males; Oct., Nov.).

(4213) PIRANGA ARDENS (Tschudi).

Phoenisoma ardens Techudi, Arch. für Naturg., 1844, vol. 1, p. 287 (central Peru). Rio San Miguel, 4,500 feet, 1 male (breeding, Oct. 5).

(4314) PIRANGA TESTACEA TSCHUDII Berlepoch and Stehmann.

Pyranga testacea tschudii Berlepsch and Stolzmann, Proc. Zool. Soc., 1892, p. 375 (Lima); Ornis, 1906, p. 82 (Santa Ana).

Chauillay, 1 male, 2 females; Rio Comberciato, 1 female.

(4333) TACHYPHONUS RUFUS (Boddmert).

Tangara rufa Boddaert, Tabl. Pl. Enl., 1783, p. 44 (Cayenne).

Tachyphonus melaleucus Sciater and Salvin, Proc. Zool. Soc., 1876, p. 16 (Maranura; Huiro; Potrero).

Tachyphonus rufus Berlepsch and Stolzmann, Ornis, 1906, p. 82 (Santa Ana; Idma).

Santa Ana, 2 males (1 breeding, Oct. 25); Idma, 2 males, 2 females (1 breeding, Oct. 19).

(4344) TACHYPHONUS RUFIVENTER (Splx).

Tanagra rufiventer SPIX, Av. Bras., vol. 2, 1825, p. 37, pl. 1, fig. 1.

A female and an immature male are apparently referable to this species, of which I have seen no other specimens.

Rio Cosireni, 1 male, immature, 1 female (breeding).

(4870) HEMITHRAUPIS FLAVICOLLIS CENTRALIS (Helimayr).

Nemosia flavncollis centralis HELLMAYE, Nov. Zool., vol. 14, 1907, p. 350 (Humay tha. Rio Madeira).

Our specimens agree with others from the Beni region of Bolivia and Matto Grosso, Brazil, in the jet blackness of the black areas. One of two males from the Rio Roosevelt, however, resembles a Cayenne specimen in the color of the black areas.

Rio Cosireni, 2 males (breeding).

(4383) THLYPOPSES INORNATA (Taczanowski).

Nemosia inornata Taczanowski, Proc. Zool. Soc., 1879, p. 228 (Tambillo, Peru).

Identified from descriptions only. Our specimen (unsexed) is more olive and less refuscent than the plate in the Catalogue of Birds of the British Museum.⁵⁷

San Miguel Bridge, 1.

[#] Vol. 11, pl. 13, fig. 2.

(4387) THLYPOPSES RUFICEPS (FOrbigny and Lafresnaye).

Sylvia ruficepe d'Orbigny and Lafresnave, Syn. Av., pt. 1, 1837, p. 30 (Yuracares, Bolivia).

Thlypopsis ruficeps Berlepsch and Stolemann, Ornis, 1906, p. 82 (Idma).

Our specimens agree with a topotypical series.

Idma, 1; San Miguel Bridge, 3; Torontoy, 6; Calca, 1.

(4397) CHLOROSPINGUS FLAVIGULARIS FLAVIGULARIS (Scieter).

Pipilopsis flavigularis SCLATER, Rev. Zoel., 1852, p. 8 (New Grenada).

Chlorospingus flavigularis parvirostris Chapman, Bull. Amer. Mus. Nat. Hist., vol. 14, 1901, p. 227 (Inca Mine—Santo Domingo, southeastern Peru).—Beelepsch and Stolemann, Ornis, 1906, p. 82 (Idma).

The acquisition of additional topotypical material of both flavigularis and "parvirostris" shows that the latter form is based on an average difference quite lost by individual variation. It is not in my opinion worthy of recognition. Inhabits the Subtropical Zone. Idma, 5; San Miguel Bridge, 4.

(4404) HEMISPINGUS ATROPILEUS AURICULARIS (Cabanis).

Chlorospingus auricularis Cabanus, Journ. für Ornith., 1873, p. 318 (Maraynioc, Peru).

The difference between the northern and southern forms of this species appears to be subspecific. Inhabits the humid Temperate Zone.

Occobamba Valley, 2.

(4409) HEMISPINGUS SUPERCILIARIS NIGRIFRONS (Lawrence).

Chlorospingus nigrifrons LAWRENCE, Ibis, 1875, p. 384 (Ecuador).

Inhabits the humid Temperate Zone. Our specimens agree with several from southern Colombia.

Occobamba Valley, 2 (1, July 29, breeding); above Torontoy (9,500 feet), 1 (May 4, breeding).

(4412) HEMISPINGUS FRONTALIS FRONTALIS (Techudi).

Hylophilus frontalis TSCHUDI, Wiegm. Arch., 1844, vol. 1, p. 284 (Peru). Chlorospingus frontalis Berlepsch and Stolzmann, Ornis, 1906, p. 83 (Santa Ana).

Inhabits the Subtropical Zone. I am unable to separate the Colombian from the Peruvian birds. H. f. oleagineus should, therefore, in my present opinion, be synonymized with frontalis. Son Missuel Pridge 6

San Miguel Bridge, 6.

(4421) PSEUDOSPINGUS XANTHOPHTHALMUS (Tacsanowski).

Dacnis zanthophthalma Taczanowski, Proc. Zool. Soc., 1874, p. 510 (Maraynioc, Peru).

Heller secured a male of this rare species heretofore known only from two males and three females from Maraynioc and a female

se See Bull. Amer. Mus. Nat. Hist., vol. 26, 1917, p. 621.

from Tamiapampa (altitude, 9,000 feet). The bird agrees with descriptions.

Occobamba Valley, 9,100 feet, 1.

(4428) MICROSPINGUS TRIFASCIATUS Taczanowski.

Microspingus trifasciatus Taczanowski, Proc. Zool. Soc., 1874, p. 132, pl. 19, fig. 1 (Maraynioc, Peru).

Heller secured this uncommon species at timber line in the humid Temperate Zone.

Cedrobamba, 3.

(4437a) SCHISTOCHLAMYS ATRA OLIVINA (Sciater).

Tanagra olivina [female] Sclater, Proc. Zool. Soc., 1864, p. 607 (Cuyaba, Brazil) — Sclater and Salvin, Proc. Zool. Soc., 1876, p. 16 (Maranura).

7Schistochlamys atra grisea Cory, Field Mus. Pub. 190, 1916, p. 346 (Rioja, Peru). Orchesticus ater [male] Sclatzr and Salvin, Proc. Zool. Soc., 1876, p. 16 (Huiro). Schistochlamys atra Berlepsch and Stolzmann, Ornis, 1906, p. 83 (Idma).

Inhabits the Tropical Zone. A large series from Matto Grosso averages slightly darker, especially below, than specimens from Cayenne and northeastern Venezuela (which may be considered typically to represent atra), but the black throat areas are not so intense and the black of the forehead grades insensibly into the gray of the crown or hind head and is not therefore sharply defined from it as it is in our specimens of true atra. Our Peruvian specimens average slightly darker in general coloration than those from Matto Grosso, but agree with them in the color of the black frontal areas and gradual change from black to gray on the crown. They should therefore unquestionably be referred to the southern rather than the northern form of this species and it seems probable that S. a. grisea Cory should also be placed here.

Santa Ana, 2; Idma, 2 (Oct. 20, breeding).

Family ICTERIDAE.

ORIOLES, CASSIQUES, Etc.

(4445a) OSTINOPS DECUMANUS MACULOSUS Chapman.

Ostinops decumanus maculosus Chapman, Proc. Biol. Soc. Wash., vol. 33, July 24, 1920, p. 26.

Ostinops decumanus Berlepsch and Stolzmann, Ornis, 1906, p. 84 (Pampa de Derrumbe: Santa Ana).

Rio Cosireni, 1; Chauillay, 1.

(4447) OSTINOPS ATROVIRENS (d'Orbigny and Lafresnaye).

Cassicus atrovirens d'Orbigny and LAFRESNAYE, Syn. Av., pt. 2, 1838, p. 1 (Yungaseni, Bolivia).

Ostinops atrovirens Sciater and Salvin, Proc. Zool. Soc., 1876, p. 16 (Huiro).— Berlepsch and Stolzmann, Ornis, 1906, p. 85 (Idma).

Locally common in the Subtropical Zone.

Idma, 5; San Miguel Bridge, 3.

(4457) CASSICUS CHRYSONOTUS d'Orbigny and Lafresnaye.

Cassicus chrysonotus d'Orbigny and Lafresnaye, Syn. Av., pt. 2, p. 3 (Yungas, Bolivia).

Torontoy, 1.

(4479) AGELAIUS THILIUS (Molina).

Turdus thilius Molina, Sagg. Storr. Nat. Chile, 1782, p. 211 (Chile).

Agelasticus thilius Sclater and Salvin, Proc. Zool. Soc., 1869, p. 153 (Tungasuca).

Agelaeus thilius Berlepson and Stolzmann, Ornis, 1906, p. 103 (Suriti; Cuzco).

Calca, 1.

Family CORVIDAE.

CROWS, JAYS.

(4547) CYANOCORAX VIOLACEUS Du Bus.

Cyanocorax violaceus Du Bus, Bull. Acad. Brux., vol. 14, 1847, p. 103 (Peru).

A species of the Tropical Zone. Rio Comberciato, 2.

(4549) XANTHOURA YNCAS YNCAS (Boddaert).

Corvus yncas Boddaert, Tabl. Pl. Enl., 1783, p. 38 (Peru).

Cyanocorax incas Sclater and Salvin, Proc. Zool. Soc., 1876, p. 16 (Huiro).

Xanthoura yncas Berlepsch and Stolemann, Ornis, 1906, p. 85 (Idma).

Common in the Subtropical Zone.

San Miguel Bridge, 6; Santa Rosa, 1; Idma, 2.

(4555) CYANOLYCA JOLYAEA (Bomparte).

Cyanocitta jolyaca Bonaparte, Journ. für Ornith., 1853, p. 47 (Peru).

Xanthoura jolyaca Berlepsch and Stolzmann, Ornis, 1906, p. 85 (Tambillo).

(4555a) CYANOLYCA VIRIDICYANEA CUZCOENSIS Scienter.

Cyanolyca viridicyanea cuzcoensis Sclater, Ibis, 1917, p. 465, pl. 8, fig. 1 (Huasampilla, altitude 10,000 feet, Peru).

This form requires comparison with *C. jolyaea* of which I have seen no specimens. It inhabits the forests of the humid Temperate Zone and hence is not found in the treeless Cuzco region.

Torontoy (9,500 feet), 1.

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Saac Lea LL.D.

Who assembled the original collection of gems that now bears his name in the United States National Museum.

# SMITHSONIAN INSTITUTION UNITED STATES NATIONAL MUSEUM Bulletin 118

# HANDBOOK AND DESCRIPTIVE CATALOGUE OF THE COLLECTIONS OF GEMS AND PRECIOUS STONES IN THE UNITED STATES NATIONAL MUSEUM

BY

#### GEORGE P. MERRILL

Head Curator of Geology, United States National Museum

ASSISTED BY

MARGARET W. MOODEY AND EDGAR T. WHERRY



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May 31, 1922
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#### ADVERTISEMENT.

The scientific publications of the United States National Museum consist of two series, the *Proceedings* and the *Bulletins*.

The *Proceedings*, the first volume of which was issued in 1878, are intended primarily as a medium for the publication of original, and usually brief, papers based on the collections of the National Museum, presenting newly acquired facts in zoology, geology, and anthropology, including descriptions of new forms of animals, and revisions of limited groups. One or two volumes are issued annually and distributed to libraries and scientific organizations. A limited number of copies of each paper, in pamphlet form, is distributed to specialists and others interested in the different subjects as soon as printed. The dates of publication are recorded in the tables of contents of the volumes.

The Bulletins, the first of which was issued in 1875, consist of a series of separate publications comprising chiefly monographs of large zoological groups and other general systematic treatises (occasionally in several volumes), faunal works, reports of expeditions, and catalogues of type-specimens, special collections, etc. The majority of the volumes are octavos, but a quarto size has been adopted in a few instances in which large plates were regarded as indispensable.

Since 1902 a series of octavo volumes containing papers relating to the botanical collections of the Museum, and known as the *Contribu*tions from the National Herbarium, has been published as bulletins.

The present work forms No. 118 of the Bulletin series.

WILLIAM DEC. RAVENEL,
Administrative Assistant to the Secretary
In charge of the United States National Museum.

WASHINGTON, D. C., January 23, 1922.

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#### PREFATORY NOTE.

In the annual report of the United States National Museum for 1900 (1902) there was published a descriptive catalogue of the collections of gems in the United States National Museum, as prepared by Mr. Wirt Tassin, then assistant curator in charge of the Division of Mineralogy, assisted by A. S. Eakle, subsequently professor of mineralogy in the University of California. As this catalogue has long been out of print, and as the collection has increased considerably since it appeared, a new edition has been decided upon. In this, however, a different method of treatment has been adopted, and the subject matter has been quite largely rewritten, so that it represents an essentially new work.

In order that just credit may be given to all concerned it may be well to state that the preparation of the catalogue was begun in 1916 by Dr. Edgar T. Wherry, then assistant curator in charge of the mineralogical collection. His resignation in 1917 caused a long delay, and meanwhile, during the occupancy of the building by the War Risk Bureau (October, 1917, to March, 1919), it was decided to entirely rearrange and recatalogue the collection which had been heretofore included with the general collection of minerals. work, which involved as well the weighing and measuring of each individual stone, has been slow and laborious, but has been carried through in almost its entirety by Miss Margaret W. Moodey, the recorder for the department. In preparing the text so much of the edition of 1902 as was suitable has been retained (see particularly pp. 141-178), to which has been added the descriptive matter prepared by Doctor Wherry. Important additional matter is furnished in the accounts of the pegmatites and their associated minerals, that of southern California having been prepared by Dr. W. T. Schaller, for several years custodian of the collection. Other important additions are the references to the Gardner Williams collection of rocks from the diamond mines of South Africa, the list of gem names and the table for the identification of precious stones.

In addition to portraits of the founder and benefactor of the collection, and two colored plates illustrating gems in the collection, there have been added a number of plates showing typical localities from which gems are mined.

GEORGE P. MERRILL.

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## HANDBOOK AND DESCRIPTIVE CATALOGUE OF THE COLLECTIONS OF GEMS AND PRECIOUS STONES IN THE UNITED STATES NATIONAL MUSEUM.

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ASSISTED BY

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#### 1. HISTORY AND ARRANGEMENT OF THE COLLECTION.

In 1884 Prof. F. W. Clarke, then honorary curator of the Division of Mineralogy, prepared an exhibit of American precious stones as a part of the United States National Museum's contribution to the New Orleans exposition. The same collection was displayed at the Cincinnati exposition in the following year, after which it was returned to Washington and incorporated in the mineral collection of the museum. From 1886 to 1890 the growth of the collection was steady though slow. In 1891 the greater part of the collection of precious stones made by Dr. Joseph Leidy, of Philadelphia, was purchased by the museum and combined with what was already on hand to form an exhibit for the World's Columbian Exposition at Chicago in 1893, the whole being returned to Washington when that exposition closed.

The great popularity of these collections, as attested by the number of visitors and their equally numerous queries, impressed upon the Museum authorities the advisability of extending the series and building it up systematically, a work which, though at once undertaken, proceeded at first slowly and with difficulty owing to the expense involved. Fortunately this has to a considerable extent been alleviated through the magnanimity of a private individual. The collections are still, however, poorly balanced, lacking a satisfactory showing of the rarer and more highly priced stones, a single one of which, of suitable size for exhibition, would consume the available income for an entire year. It is not too much to hope and expect that this discrepancy, like the last, may also be remedied through individual action.

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In 1894 Mrs. Frances Lea Chamberlain bequeathed to the museum a collection of precious stones which had been assembled by her father, Dr. Isaac Lea (pl. 1). Her husband, Dr. L. T. Chamberlain (pl. 2), who subsequently (1897) became honorary curator of the collection, added a large number of specimens, and on his death bequeathed a sum of money, the income of which is to be used for their further increase.

In addition, many specimens have been received throughout this period as gifts from individuals and transfers from the United States Geological Survey. These various collections have been combined, and are now exhibited as "The Isaac Lea Collection," although the individual stones are differentiated by label. The exhibit at present is comprised in a row of table cases, extending down the center of the Mineral Hall. (See pl. 3.) At the west end of this row, immediately to the right of the entrance to the hall, stands a large group of amethyst crystals from Brazil. In table cases fronting the windows on the south side of the hall are other series illustrating the properties of precious stones, their appearance in the rough as contrasted with the cut form; gem minerals in the matrix or as occurring in nature, and artificial and imitation stones. Finally, an upright case between the windows at the center of the hall contains many semiprecious stones—that is, stones used in the manufacture of small ornaments, rather than for personal adornment.

It may be added that in building up the collection an attempt has been made to show the possibilities of commonplace material; that there is a goodly number of stones, in themselves of little intrinsic value, which when properly cut and mounted are not merely beautiful, but have the additional value of being out of the line of the usual material sold in shops. In this connection particular attention may be called to the cabochons of silicified wood, obsidian, epidotic granite (unakite), and green feldspar (amazonstone).



Leander J. Chambolin

Who, in memory of his wife, Frances Lea, endowed the Isaac Lea collection in the United States National Museum.

### 2. NAMES AND PHYSICAL AND CHEMICAL PROPERTIES OF PRECIOUS STONES.

About 1,200 mineral species are now (1920) known to science, and of these somewhat less than one-tenth, or in round numbers 100, possess the properties of beauty and durability to such an extent that they are of importance, interest, and value as precious and semiprecious stones or gems. The present paper comprises descriptions of these minerals, lists of the cut stones of each represented in the collection, and notes on methods of identification, uses, etc. By way of introduction to the descriptive portion, brief definitions of the properties of the minerals and other explanatory notes are given; no attempt has been made, however, to make this a treatise on mineralogy, chemistry, or physics, and for further information concerning the various features discussed, reference should be made to works on those subjects.

Names.—The names of minerals have in part come down to us from the ancients, and in part been constructed by adding the suffix ite (from ites, similar to) or lite (from lithos, stone) to an appropriate root. As far as possible the names generally accepted by mineralogists have been adopted here.

Many stones, in addition to the standard names by which they are known to science, are also called by one or more synonyms, usually popular or trade names; the most important of these are added in each tabular description.

Chemical composition.—The chemical composition and formulas of the minerals are stated in a simple form. For the benefit of those unfamiliar with chemical terms it may be explained that the majority of mineral substances are compounds of two or more elements, in more or less definite proportions; and that these compounds are named by stating first the names of the elements forming the electropositive or basic part of the compound, and then those of the elements forming the electronegative or acidic part. The names of the negative elements are combined, usually in abbreviated form, and provided with significant suffixes, such as ide when a single element is concerned, and ate when oxygen is also present.

The formulas of the compounds are derived by placing the symbols of the elements together, with subscript figures to indicate the number of atoms of each represented. For definitions of the various chemical terms, and additional details, the reader is referred to textbooks of chemistry. The following table shows the elements that may be present in important amounts in precious stones, with their symbols:

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#### Metals forming the bases of precious stones.

Aluminum Al	Manganese Mn
Barium Ba	Mercury (kydrargyrum) Hg
Beryllium (or glucinum) Be	Nickel
Calcium	' Potassium (kalium) K
CeriumCe	Sodium (natrium) Na
ChromiumCr	Tin (stannum) Sn
CobaltCo	Titanium Ti
Copper (cuprum) Cu	Uranium U
Hydrogen H	Vanadium V
Iron (ferrum) Fe	Yttrium Y
Lead (plumbum) Pb	ZincZn
LithiumLi	ZirconiumZr
Magnesium Mg	

#### Nonmetals forming the acid portions of precious stones.

Boron	В	Oxygen	0
		Phosphorus	
		Silicon	
Columbium	Cb	Sulphur	S
Fluorine	F	*	

Crystallization.—When a chemical compound passes from the liquid or gaseous state into the solid condition, cohesion and chemical affinity tend to draw its atoms together, and if these become grouped in a regular manner solids bounded by plane surfaces result; these are known as crystals. Six crystal systems (one of them consisting of two subsystems) are recognized, as follows: 1, Isometric. or cubic, comprising those crystals developed exactly alike in the six directions in space (front, back, right, left, up, and down), at right angles to one another; these have the general aspect of spheres. regularly flattened at an even number of equal intervals, and include the cube, regular octahedron, rhombic dodecahedron, etc.. as well as combinations of these simple forms. 2, Tetragonal, comprising those crystals developed according to two different patterns, one repeated four times in directions at equal intervals in a plane, the other twice in the directions at right angles to that plane, all being at right angles to one another. The crystals of this system are made up of pinacoids, prisms, and pyramids. 3, Hexagonal, comprising crystals developed according to two different patterns, one repeated six times in directions at intervals lying 60° apart in a plane, and the other twice in the directions at right angles to that plane; the forms are like those of the tetragonal system. Trigonal (a subsystem of the hexagonal), comprising crystals developed according to two different patterns, one repeated three times at intervals lying 120° apart in a plane, and the other twice in the directions at right angles to that plane. 4, Orthorhombic system comprising those crystals developed according to three different

patterns, each repeated twice, in opposite directions, all again at right angles; the crystals of this system are made up of combinations of pinacoids, prisms, domes, and pyramids. 5, Monoclinic, system, comprising crystals developed like the orthorhombic, but with the patterns reappearing in one plane twice at angles less, and twice at angles greater, than right angles; the forms are like those of the preceding system. 6, Triclinic system, comprising crystals developed like the two preceding systems, but with none of the patterns repeated exactly at right angles to one another; the forms are essentially the same as those of the two preceding systems.

In addition, a few minerals have their atoms irregularly arranged, and consequently are without crystal form; to these the term amorphous is applied.

Color.—The color of an object expresses the character of the ligh reflected or transmitted by it. The principal terms used in describing it are: White, gray, black, violet, blue, green, yellow, red, and brown. There are also many intermediate hues, best described by a combination of terms, as blue-green, etc. Colors may be divided into two classes:

1. Essential or idiochromatic colors, due to the chemical elements which make up a compound. They are definite and characteristic for each substance and only disappear when it is decomposed. The principal elements yielding colors in the order of their most frequent occurence in precious stones are:

Elements.	Valence.	Colors produced
	ferrous, Fe ⁱⁱ	green.
Iron	.  { ferric, Fe ¹¹¹	red, brown, yellow.
	both together	blue, black,
Chromium	∫chromic, Cr ⁱⁱⁱ	green, violet, red.
	negative, Crvi	red, vellow.
Vanadium	Vill and V	red, brown, yellow.
	∫manganous, Mn ⁱⁱ	red, pink.
Manganese	manganic, Mniii	violet.
Cannas	cuprous, Cui	red.
Copper	cupric, Cu ¹¹	blue, green.
Titanium	titanic, Ti ¹¹¹	
Nickel	nickelous, Ni ¹¹	green.
Cobalt	cobaltous, Coii	red, blue.
Uranium	uranic, U'vi	greenish-yellow.
Molybdenum	negative, Movi	yellow, red.
Neodymium	neodymic, Ndiii	red-violet.
Cerium	cerous, Ceiti	brown.

2. Nonessential or allochromatic colors, due to impurities or foreign constituents in a substance. They may vary widely from one specimen to another and may be of three different types: 1, Produced by evident, distinct particles, which in themselves show essential colors. Thus, finely divided ferric oxides are frequently inclosed in other

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minerals, and render them yellow, brown, or red. 2, Disperse colors, due to submicroscopic inclusions, and varying with their shape, size, or arrangement. These colors are thought to have been developed, in part at least, by exposure in the earth to radio-active substances, slight decomposition having thereby been effected, and traces of the constituent elements set free. Heating usually destroys these colors, since it causes the free elements to reunite, but exposure to radiant energy of various kinds often restores them. 3, Internal reflection colors, due to symmetrically arranged inclusions, or to lamellae of extreme thinness, producing interference of light.

A special color phenomenon remains to be considered. Some minerals transmit light of different colors in different directions, and are said to be pleochroic. The most striking instance of this among precious stones is iolite, which is sometimes called "dichroite" because of this very property; in one direction it appears intense blue, in another somewhat paler blue, and in the third pale yellow. In many cases, however, the difference in color is less striking, and special means must be used in order to detect it. An instrument, called a dichroscope, is sometimes used for this purpose. It consists of a metal tube containing a cleavage piece of Iceland spar; at one end it is pierced with a small square hole, and at the other has a magnifying lens to serve as an eyepiece; the hole appears double when viewed through the latter. When a pleochroic stone is placed in front of the square hole, the two images of the hole will be differently colored.

Another method of observing pleochroism makes use of the polarizing nicol prism in the microscope. The stone is placed on the stage, and the polarizer introduced; the stone is observed in one position and again after turning the stage through 90°; one of the pleochroic colors will be seen in each of these positions.

It should be noted that isometric minerals, which are isotropic between crossed nicols, show no pleochroism; tetragonal, hexagonal, and trigonal ones may show two colors, while those of the three remaining crystal systems in general show three colors.

Luster.—The luster or brilliancy of a mineral is a physical phenomenon connected with the manner in which light is refracted by it; the principal types are metallic, adamantine, and vitreous, but in addition some minerals of fundamentally vitreous luster possess certain peculiarities of structure, and as a result exhibit lusters resembling those of familiar substances, as waxy, greasy, silky, etc.

Hardness.—On the hardness of a mineral is dependent its resistance to scratching or abrasion. It is usually described by reference to a standard scale of 10 minerals, which are, beginning with the softest—1, talc; 2, gypsum; 3, calcite; 4, fluorite; 5, apatite; 6, orthoclase or microcline; 7, quartz; 8, topaz or beryl; 9, corundum (ruby or sapphire); and 10, diamond. Each of these will scratch all pre-

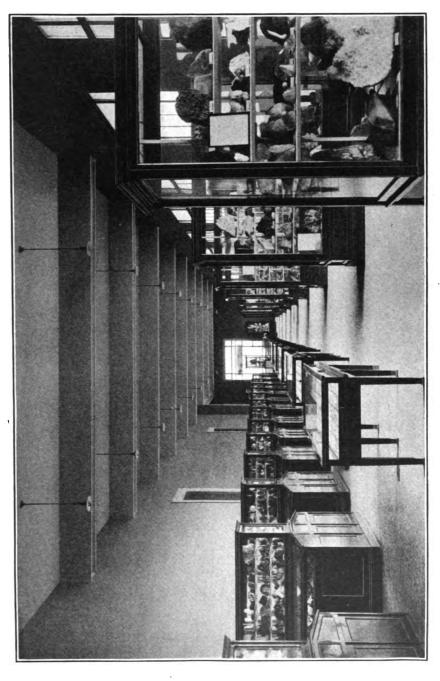
ceding in the series and be scratched by all following. In general only those minerals which possess a hardness greater than 6 in this scale—that is, which will at least scratch orthoclase—are sufficiently durable to be used as precious stones.

Specific gravity.—The specific gravity of a substance is its weight compared with an equal bulk of pure water; thus, the statement that diamond has a specific gravity of 3.5 means that it is three and one-half times as heavy as water. This property is characteristic of many precious stones and is of considerable value in their identification. It is determined by weighing the stone first in air and then suspended in water. The first weight, divided by the difference between the two, gives the value desired. For details as to the apparatus used for this purpose, books on mineralogy or physics must be consulted.

Optical properties. Index of refraction.—When light passes obliquely from one transparent substance to another, its direction is, in general, altered at their boundary. The well-known phenomenon of the apparent bending of a stick thrust into water is an illustration of this. The extent to which light entering minerals from the air is shifted is called their index of refraction; in mathematical terms this is the ratio between the sine of the angle of incidence and that of the angle of refraction. In amorphous minerals and in those crystallizing in the isometric system, the index of refraction is the same in all directions; in those crystallizing in the systems derived from a revolution ellipsoid-namely, the hexagonal, trigonal, and tetragonal—there are two different indices; and in those crystallizing in the remaining systems there are three. The last two groups are said to possess double refraction, which in the first is the difference between the two indices; in the second, the difference between the largest and smallest.

In a few minerals, notably in Iceland spar (transparent calcite), the double refraction is so strong that an object observed through the mineral appears double; in most cases, however, the double refraction is too slight to be rendered visible in this manner, and special means must be employed for its recognition; polarized light (light the vibration of which is limited to a definite plane) is generally used for this purpose. For details of the phenomena connected with polarized light, books on optical mineralogy must be consulted. It may be mentioned here, however, that it is most conveniently obtained by causing ordinary light to traverse prisms of Iceland spar so constructed that only one of the two rays into which the light is split is actually transmitted. The light emerging from such a prism (called a "nicol" after its inventor) is vibrating in a single plane; and if two nicols are disposed so that the planes are at right angles no light will be able to traverse the system. A substance with single

refraction placed between them is without effect on this extinction of the light and is said to be isotropic. But a substance possessing double refraction will, in all but one or two directions, cause light to be transmitted and is then described as anisotropic. The latter is also subdivided on the basis of number of optic axes (directions along which polarized light is not affected), crystals derived from revolution-ellipsoids having one such axis and being termed uniaxial, while those not so derivable have two and are termed biaxial. There is still another feature which is usually stated in connection with anisotropic crystals—the optical sign. When the greatest index of refraction is shown in the direction of the optic axis, in uniaxial crystals, or in the acute angle between the two optic axes in biaxial ones, the sign is described as plus (+); and in reverse case it is minus (-).



Southern Bouth A. Amer.
Southern Bouth America.
Tropical South America.
Southern Colombia.
Southern Colombia.
Tropical south America; subspecies Peru.
Tropical and eastern Brazil.
Tropical and eastern Brazil.
Tropical and eastern Brazil.

#### · 3. DESCRIPTIVE CATALOGUE OF THE COLLECTIONS.

The arrangement of the gem names in this catalogue is alphabetical throughout so far as practicable. Under each mineral or gem is given in tabular form some of the more striking qualities of a descriptive or determinative nature, followed by remarks on the mode of occurrence and such other miscellaneous information as it is thought will be of value. In the catalogue proper the material is arranged in the following order: Name, locality, cut, color, weight, measurements, and catalogue number. The weights are given in the newly introduced metro-carats. The specimens are listed by localities, alphabetically, and under each locality are arranged in the order of decreasing weights, except where several stones are described together, these being placed at the end of the list for that particular locality.

Adularia.—See under Feldspar.

Agate.—See under Chalcedony.

Alabaster.—See under Gypsum.

Albite.—See under Feldspar (Moonstone).

Alexandrite.—See under Chrysoberyl.

Almandite.—See under Garnet.

Amazonstone.—See under Feldspar.

#### AMBER.

Synonym.—Succinite.

Composition.—A resinous substance, containing carbon, hydrogen, and oxygen.

Crystallization.—Amorphous.

Color.—Yellow, orange-yellow, brown-yellow, or rarely red.

Luster.—Resinous; transparent to translucent.

Hardness.—2.5; too soft for extensive use as a precious stone.

Optical properties.—Mean refractive index 1.54; is isotropic excepting when in a condition of strain.

Specific gravity.—1.07; noticeably light.

Amber is a poor conductor of heat and electricity, becoming electrified when rubbed on cloth so that it will attract small bits of paper. It can be distinguished from imitations such as rosin and celluloid by being less inflammable, though it burns readily with a rich yellow flame, yielding an aromatic odor. Heated to 150° C. it begins to soften and melts at about 250°. From most minerals it may be distinguished by its extreme lightness and its solubility in alcohol.

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It occurs in sediments of the later geological periods, representing the fossil resin of the tree *Pinus succinifera* and other plants; sometimes contains insects which became embedded in the material while it was soft and in a pitch-like condition. It is used chiefly for beads, earrings, and other similar ornaments. The value of the crude material is but a few cents an ounce.

#### LIST OF SPECIMENS.

#### COAST OF THE BALTIC SEA.

Two cuff buttons; pale yellow; opaque	No.	674
Breastpin of 3 facetted beads and pendant; light yellow-brown		
Necklace of 50 facetted beads: light yellow-brown		
Bracelet of 16 rectangular links, 20 by 15 mm. average size, and buckle; alternating pale yellow and clouded amber. Isaac Lea collection		
INDIA (BURMA).		
Heart-shaped cabochon; yellow-brown; 8.2 carats; 20 by 7 mm	No.	673
ITALY (SICILY).		
Ten polished pieces; light and dark brown; various sizes and shapes; total weight, 92.5 carats.	No.	671
Pendant; brown; 19.3 carats; 45 by 18 by 10 mm. Isaac Lea collection		
LOCALITY NOT RECORDED.		
Necklace of 62 facetted beads, graduated sizes; yellow-brown; William H. Forwood bequest	No.	677
Amethyst.—See under Quartz.		

#### ANDALUSITE.

Variety.—Chiastolite or macle.

Composition.—Aluminum orthosilicate, Al₂O(SiO₄).

Crystallization.—Orthorhombic.

Color.—Gray when pure; often showing brown-green, or yellow-green, and rarely brown, pink, or violet hues, owing to the presence of impurities of unknown nature; rather strongly pleochroic, green to yellow or even to red.

Luster.—Vitreous; transparent to translucent.

Hardness.—7.5; a durable stone.

Specific gravity.— $3.20 \pm 0.05$ .

Optical properties.—Mean refractive index, 1.64; double refraction moderate, 0.01; biaxial, negative.

Chiastolite contains symmetrically arranged carbonaceous matter yielding in polished specimens a black cross on gray background. It may be distinguished from tourmaline and other similar minerals by its pleochroism, specific gravity, and optical properties. It occurs in metamorphic rocks, especially mica schist.

Uses.—Clear and alusite is cut facetted; chiastolite is cut cabochon and used for scarfpins, and ranks as a curiosity rather than a gem.

#### LIST OF SPECIMENS.

#### BRAZIL.

Step brilliant, rectangular girdle; brown-green; 1.39 carats; 11 by 6 by	
3 mm	. 568
Brilliant, rectangular girdle; dark green; 1.03 carats; 7 by 6 by 4 mm No	. 566
Step, rectangular girdle; brown-green; 0.83 carat; 10 by 4.5 by 2 mm No	. 569
Step brilliant, square girdle; brown-green; 0.72 carat; 6 by 3.5 mm No	. 567

Aquamarine.—See under Beryl.

Aragonite.—See under Calcite and Aragonite.

#### AXINITE.

 $\label{local_composition} \begin{array}{lll} \textit{Composition}. & -\text{Iron calcium aluminum hydrous boro-silicate,} \\ \text{FeCa}_2\text{Al}_2(\text{OH})(\text{BSi}_4\text{O}_{15}). \end{array}$ 

Crystallization.—Triclinic; habit wedge-shaped.

Color.—Brown; sometimes violet, violet-brown, or yellow-brown; essential, due to the iron, and to manganese which may replace it; strongly pleochroic, green to brown to blue.

Luster.—Brilliant-vitreous; transparent.

Hardness.—6.5; a fairly durable stone.

Specific gravity.— $3.30 \pm 0.05$ .

Optical properties.—Mean refractive index 1.68; double refraction weak, 0.009; optically biaxial, negative.

Axinite may be distinguished from tourmaline and other similar minerals by its pleochroism, specific gravity, and optical properties. It occurs in veins, chiefly in metamorphic rocks and is in little demand as a precious stone, because of unattractive colors and brittleness. Value purely arbitrary.

#### LIST OF SPECIMENS.

#### FRANCE (DAUPHINÉ).

Step-brilliant, square girdle; violet-brown; 1.59 carats; 7.5 by 4.5 mm.... No. 581

#### AZURITE.

Composition.—Hydrous copper carbonate, Cu₃(OH)₂(CO)₂.

Crystallization.—Monoclinic.

Color.—Dark blue, characteristic of many compounds of copper.

Luster.—Vitreous; translucent to opaque.

Hardness.-4; too soft for extensive use as a precious stone.

Specific gravity.— $3.80 \pm 0.05$ .

Optical properties.—Mean refractive index 1.9; double refraction very strong, 0.20; biaxial, positive.

The mineral dissolves readily in hydrochloric acid with effervescence to a yellow solution. It may as a rule be distinguished from other blue precious stones by its intense color, softness, and solubility. It occurs in veins and pockets and has been derived from sulphide ores through decomposition by surface water, as has malachite, with which it is very commonly associated. Used for ornaments, scarfpins, etc.; the value as a gem is little more than the cost of cutting. (See under Malachite.)

#### BENITOITE.

Composition.—Barium titano-silicate, BaTiSi,O.

Crystallization.—Hexagonal (trigonal), holohedral.

Color.—Pale to deep blue; pleochroic.

Luster.—Vitreous.

Hardness.—6.5.

Specific gravity.—3.64 - 3.67.

Optical properties.—Refractive index 1.757 to 1.804. Double refraction strong and positive. High index of refraction and marked pleochroism are distinguishing features of the mineral. So far as at present known it occurs only in natrolite veins cutting serpentine. It is usually cut as brilliant, more rarely cabochon. A limited supply of this mineral has as yet been found (pl. 4). It is, therefore, little used, though of good quality.

LIST OF SPECIMENS.

UNITED STATES.

California.

San Benito County:

#### BERYL.

Varieties.—Common, aquamarine, emerald, morganite (vorobievite), and golden beryl.

Composition.—Beryllium aluminum metasilicate, Be₃Al₂(SiO₃)₆.

Crystallization.—Hexagonal; habit usually prismatic, rarely tabular.

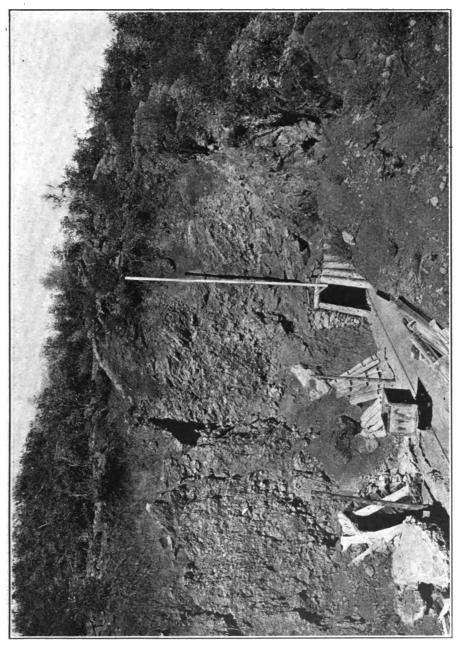
Color.—Colorless when pure; often showing green, blue, yellow, or pink hues, and in part named accordingly: Pale blue, green-blue, or blue-green, aquamarine; intense green, emerald; yellow, orange-yellow, or brown-yellow, golden-beryl; and pink, morganite, or vorobievite. Slightly pleochroic, if deeply colored.

Luster.—Vitreous; transparent.

Hardness.—8 (less when altered); a durable stone.

Specific gravity.— $2.75 \pm 0.10$ .

Optical properties.—Mean refractive index 1.58; double refraction weak, 0.005; uniaxial, negative. With the microspectroscope emerald yields two absorption bands in the orange, which form a characteristic distinction from green tourmaline, green corundum,



and imitation emerald (green glass). Other varieties of beryl show no spectrum. Other distinctive characters are color, slight pleochroism, specific gravity, refractive index, and weak double refraction.

Beryl occurs chiefly in granitic pegmatites and related formations. The famous emerald deposits of Muzo, Colombia, South America, are in a limestone thought to have been metamorphosed by solutions accompanying the intrusion of pegmatite dikes. All the transparent varieties of beryl are of more or less value as precious stones; they are usually cut facetted. The emerald is considered of greatest value, though many of the aquamarine varieties are of great beauty.

#### LIST OF SPECIMENS.

#### BERYL, common, golden, and caesium.

#### BRAZIL.

Brilliant, circular girdle; colorless; 4.67 carats; 12.5 by 6 mm		
Isaac Lea collection	io. Io	743 740
	٠٠.	. 10
RUSSIA (ALABASHKA, URAL MOUNTAINS).		
Step-brilliant; rectangular girdle; yellow; 17.46 carats; 18 by 14 by 10 mm.		714
Table, rectangular girdle; yellow; 9.27 carats; 16 by 13 by 7 mm	١٥.	715
mm	<b>ζ</b> ο.	718
Step-brilliant, rectangular girdle; yellow; 3.113 carats; 12 by 9 by 5 mm N		716
Brilliant, rectangular girdle; pale yellow; 1.73 carats; 8 by 7 by 6 mm		717
Brilliant, circular girdle; pale yellow; 1.31 carats; 8 by 5 mm	šo.	719
SIBERIA.		
Table, rectangular girdle; yellow-green; 21.46 carats; 31 by 16 by 6.5 mm	No.	713
UNITED STATES.	•	
Connecticut.		
Litchfield County:		000
Brilliant, circular girdle; yellow; 1.73 carats; 8 by 6 mm	10. 1	036
Gift of New England Mining Company	šo.	780
Brilliant, circular girdle; green-yellow; 1.09 carats; 7 by 5 mm. Gift		
of New England Mining Company	Ñο.	782
Brilliant, circular girdle; brown-yellow; 0.987 carat; 6.5 by 5 mm. Gift		-0.
of New England Mining Company	<b>\</b> 0.	784
Maine.		
Mount Apatite, Auburn, Androscoggin County:		
Brilliant, circular girdle; very pale pink; 1.19 carats; 6.5 by 5 mm N	lo. 1	836
Topsham, Sagadahoc County:		
Brilliant, circular girdle; green-yellow; 23.01 carats; 14.5 by 11 mm. (Set in gold band)	ر آ م	031
Brilliant, circular girdle; green-yellow; 5.25 carats; 12 by 7.5 mm		
Brilliant, circular girdle; yellow-green; 4.155 carats; 11 by 7.5 mm		
	vo. 1	1000
Brilliant, circular girdle; yellow-green; 3.275 carats; 10 by 7 mm N	No. 1	<b>10</b> 33
Brilliant, circular girdle; yellow-green; 3.275 carats; 10 by 7 mm M Brilliant, circular girdle; yellow-green; 1.88 carats; 8.5 by 5.5 mm	No. 1	<b>10</b> 33

#### Massachusetts.

Fitchburg, Worcester County: Brilliant, rectangular girdle; yellow-green; 0.765 carat; 6.5 by 5 by 4 mm.		787
- North Carolina.		
Yancey County, Ray's Mica Mine:  Brilliant, square girdle; colorless; 1.685 carats; 8 by 6 mm.  Brilliant, circular girdle; colorless; 1.39 carats; 7 by 5 mm.  Brilliant, circular girdle; colorless; 1.17 carats; 7 by 5 mm.  Brilliant, circular girdle; colorless; 1.15 carats; 7 by 5 mm.  Brilliant, square girdle; colorless; 1.1 carats; 7 by 5 mm.	No. No. No.	760 763 761
· Pennsylvania.		
Avondale, Delaware County:  Step-brilliant, square girdle; yellow; 3.77 carats; 10 by 7 mm  Step-brilliant, rectangular girdle; yellow-green; 2.12 carats; 8 by 6 by 4 mm		
BERYL, variety AQUAMARINE.		
BRAZIL.		
Step-brilliant, elliptical girdle; very pale green; 7.879 carats; 15 by 12.5 by 7 mm		737
Isaac Lea collection	No.	741
Isaac Lea collection		
4 mm		
· CEYLON.		
Step-brilliant, elliptical girdle; pale blue-green; 7.719 carats; 17 by 13 by 7 mm. Isaac Lea collection	No.	732
Step-brilliant, rectangular girdle; pale blue-green; 7.324 carats; 12.5 by 11 by 8.5 mm. Isaac Lea collection		3
Step-brilliant, elliptical girdle; very pale green; 1.576 carats; 10 by 7 by 5 mm. Isaac Lea collection	No.	733
Step-brilliant, elliptical girdle; pale green; 1.045 carats; 8 by 6 by 4 mm.  Isaac Lea collection		
Step-brilliant, rectangular girdle; pale green; 1.02 carats; 8 by 6 by 4 mm.  Isaac Lea collection	No.	735
Step-brilliant, elliptical girdle; pale green; 1.007 carats; 8 by 6 by 4 mm. Isaac Lea collection		
IRELAND (MOURNE MOUNTAIN).		
Brilliant, circular girdle; light blue; 1.765 carats; 8 by 6 mm	No.	745
JAPAN (SEKINOTSU, OMI).		
Brilliant, circular girdle; very pale blue-green; 7.395 carats; 12 by 9 mm Brilliant, circular girdle; very pale blue-green; 5.69 carats; 11 by 9 mm		

#### SIBERIA

Step-brilliant, elliptical girdle; blue-green; 47.94 carats; 29 by 22 by 9 mm.		
Isaac Lea collection		709
Rose, elliptical girdle; blue-green; 40.4 carats; 27 by 23 by 13 mm	No.	693
Table, rectangular girdle; blue-green; 29.6 carats; 37 by 12 by 9 mm	No.	695
Step-rose, elliptical girdle; blue-green; 22.49 carats; 26 by 17 by 9 mm	No.	694
Step-brilliant, elliptical girdle; blue-green; 12.3 carats; 19 by 16 by 7 mm		696
Step-brilliant, elliptical girdle; light green; 10.25 carats; 16 by 12 by 7 mm.	110.	000
	3.5	
Isaac Lea collection		710
Step-brilliant, rectangular girdle; blue-green; 8.5 carats; 16 by 13 by 7 mm	No.	698
Step-brilliant, rectangular girdle; blue-green; 8.2 carats; 14 by 12.5 by 6.5 mm	No	700
Table, square girdle; blue-green; 6.96 carats; 14 by 7 mm		697
Step, rectangular girdle; blue-green; 6.38 carats; 19 by 8 by 6 mm		699
Step-brilliant, elliptical girdle; blue-green; 4.9 carats; 17 by 9 by 5 mm		702
Step-brilliant, rectangular girdle; blue-green; 4.7 carats; 17 by 8 by 5 mm		703
Step-brilliant, octagonal girdle; very pale blue-green; 4.6 carats; 13 by 5 mm.	No.	704
Step-brilliant, elliptical girdle; very pale green; 4.548 carats; 16 by 11 by 5		
mm	No.	701
Step-brilliant, rectangular girdle; blue-green; 3.97 carats; 12 by 9 by 5.5 mm.		705
Brilliant-rose, elliptical girdle; deep green-blue; 3.28 carats; 12 by 8 by 6 mm.	No.	700
Isaac Lea collection	No.	711
Step-brilliant, rectangular girdle; blue-green; 2.95 carats; 10 by 9 by 5.5 mm.	No.	707
Step-brilliant, elliptical girdle; blue-green; 2.45 carats; 11 by 9 by 5 mm		706
Step-brilliant, elliptical girdle; light green; 2.048 carats; 11 by 8 by 5 mm		708
	110.	100
Step-brilliant, octagonal girdle; pale green; 1.95 carats; 9 by 5 mm. Isaac		
Lea collection	No.	712
UNITED STATES.		
Connecticut.		
Connecticut. Litchfield County:		
Connecticut.  Litchfield County: Briolette, heart-shaped girdle; blue-green; 40.44 carats; 20 by 21 by 16		
Connecticut.  Litchfield County: Briolette, heart-shaped girdle; blue-green; 40.44 carats; 20 by 21 by 16	No.	1037
Connecticut.  Litchfield County: Briolette, heart-shaped girdle; blue-green; 40.44 carats; 20 by 21 by 16 mm		1037
Connecticut.  Litchfield County: Briolette, heart-shaped girdle; blue-green; 40.44 carats; 20 by 21 by 16		1037 781
Connecticut.  Litchfield County: Briolette, heart-shaped girdle; blue-green; 40.44 carats; 20 by 21 by 16 mm.  Brilliant, circular girdle; very pale green; 1.48 carats; 8 by 6 mm. Gift of New England Mining Company.		
Connecticut.  Litchfield County:  Briolette, heart-shaped girdle; blue-green; 40.44 carats; 20 by 21 by 16 mm	No.	781
Connecticut.  Litchfield County:  Briolette, heart-shaped girdle; blue-green; 40.44 carats; 20 by 21 by 16 mm.  Brilliant, circular girdle; very pale green; 1.48 carats; 8 by 6 mm. Gift of New England Mining Company.  Brilliant, circular girdle; pale green; 1.119 carats; 7 by 5 mm. Gift of New England Mining Company.	No.	781
Connecticut.  Litchfield County:  Briolette, heart-shaped girdle; blue-green; 40.44 carats; 20 by 21 by 16 mm.  Brilliant, circular girdle; very pale green; 1.48 carats; 8 by 6 mm. Gift of New England Mining Company.  Brilliant, circular girdle; pale green; 1.119 carats; 7 by 5 mm. Gift of New England Mining Company.  Portland, Middlesex County:	No.	781
Connecticut.  Litchfield County:  Briolette, heart-shaped girdle; blue-green; 40.44 carats; 20 by 21 by 16 mm.  Brilliant, circular girdle; very pale green; 1.48 carats; 8 by 6 mm. Gift of New England Mining Company.  Brilliant, circular girdle; pale green; 1.119 carats; 7 by 5 mm. Gift of New England Mining Company.  Portland, Middlesex County:  Brilliant, rectangular girdle; deep blue-green; 14.26 carats; 17 by 15 by	No.	781 783
Connecticut.  Litchfield County:  Briolette, heart-shaped girdle; blue-green; 40.44 carats; 20 by 21 by 16 mm.  Brilliant, circular girdle; very pale green; 1.48 carats; 8 by 6 mm. Gift of New England Mining Company.  Brilliant, circular girdle; pale green; 1.119 carats; 7 by 5 mm. Gift of New England Mining Company.  Portland, Middlesex County:	No.	781 783
Connecticut.  Litchfield County:  Briolette, heart-shaped girdle; blue-green; 40.44 carats; 20 by 21 by 16 mm.  Brilliant, circular girdle; very pale green; 1.48 carats; 8 by 6 mm. Gift of New England Mining Company.  Brilliant, circular girdle; pale green; 1.119 carats; 7 by 5 mm. Gift of New England Mining Company.  Portland, Middlesex County:  Brilliant, rectangular girdle; deep blue-green; 14.26 carats; 17 by 15 by 10 mm.	No.	781 783
Connecticut.  Litchfield County:  Briolette, heart-shaped girdle; blue-green; 40.44 carats; 20 by 21 by 16 mm	No.	781 783
Connecticut.  Litchfield County:  Briolette, heart-shaped girdle; blue-green; 40.44 carats; 20 by 21 by 16 mm.  Brilliant, circular girdle; very pale green; 1.48 carats; 8 by 6 mm. Gift of New England Mining Company.  Brilliant, circular girdle; pale green; 1.119 carats; 7 by 5 mm. Gift of New England Mining Company.  Portland, Middlesex County:  Brilliant, rectangular girdle; deep blue-green; 14.26 carats; 17 by 15 by 10 mm.  Maine.  Paris, Oxford County:	No. No.	781 783 779
Connecticut.  Litchfield County:  Briolette, heart-shaped girdle; blue-green; 40.44 carats; 20 by 21 by 16 mm.  Brilliant, circular girdle; very pale green; 1.48 carats; 8 by 6 mm. Gift of New England Mining Company.  Brilliant, circular girdle; pale green; 1.119 carats; 7 by 5 mm. Gift of New England Mining Company.  Portland, Middlesex County:  Brilliant, rectangular girdle; deep blue-green; 14.26 carats; 17 by 15 by 10 mm.  Maine.  Paris, Oxford County:  Brilliant, rectangular girdle; colorless; 0.989 carat; 7 by 5.5 by 5 mm.	No. No.	781 783 779
Connecticut.  Litchfield County:  Briolette, heart-shaped girdle; blue-green; 40.44 carats; 20 by 21 by 16 mm.  Brilliant, circular girdle; very pale green; 1.48 carats; 8 by 6 mm. Gift of New England Mining Company.  Brilliant, circular girdle; pale green; 1.119 carats; 7 by 5 mm. Gift of New England Mining Company.  Portland, Middlesex County:  Brilliant, rectangular girdle; deep blue-green; 14.26 carats; 17 by 15 by 10 mm.  Maine.  Paris, Oxford County:  Brilliant, rectangular girdle; colorless; 0.989 carat; 7 by 5.5 by 5 mm  Stoneham, Oxford County:	No. No.	781 783 779
Connecticut.  Litchfield County:  Briolette, heart-shaped girdle; blue-green; 40.44 carats; 20 by 21 by 16 mm.  Brilliant, circular girdle; very pale green; 1.48 carats; 8 by 6 mm. Gift of New England Mining Company.  Brilliant, circular girdle; pale green; 1.119 carats; 7 by 5 mm. Gift of New England Mining Company.  Portland, Middlesex County:  Brilliant, rectangular girdle; deep blue-green; 14.26 carats; 17 by 15 by 10 mm.  Maine.  Paris, Oxford County:  Brilliant, rectangular girdle; colorless; 0.989 carat; 7 by 5.5 by 5 mm  Stoneham, Oxford County:  Brilliant, elliptical girdle; very pale blue-green; 3.135 carats; 10 by 9 by	No. No. No.	781 783 779 791
Connecticut.  Litchfield County:  Briolette, heart-shaped girdle; blue-green; 40.44 carats; 20 by 21 by 16 mm.  Brilliant, circular girdle; very pale green; 1.48 carats; 8 by 6 mm. Gift of New England Mining Company.  Brilliant, circular girdle; pale green; 1.119 carats; 7 by 5 mm. Gift of New England Mining Company.  Portland, Middlesex County:  Brilliant, rectangular girdle; deep blue-green; 14.26 carats; 17 by 15 by 10 mm.  Maine.  Paris, Oxford County:  Brilliant, rectangular girdle; colorless; 0.989 carat; 7 by 5.5 by 5 mm  Stoneham, Oxford County:  Brilliant, elliptical girdle; very pale blue-green; 3.135 carats; 10 by 9 by 7 mm.	No. No. No.	781 783 779
Connecticut.  Litchfield County:  Briolette, heart-shaped girdle; blue-green; 40.44 carats; 20 by 21 by 16 mm.  Brilliant, circular girdle; very pale green; 1.48 carats; 8 by 6 mm. Gift of New England Mining Company.  Brilliant, circular girdle; pale green; 1.119 carats; 7 by 5 mm. Gift of New England Mining Company.  Portland, Middlesex County:  Brilliant, rectangular girdle; deep blue-green; 14.26 carats; 17 by 15 by 10 mm.  Maine.  Paris, Oxford County:  Brilliant, rectangular girdle; colorless; 0.989 carat; 7 by 5.5 by 5 mm  Stoneham, Oxford County:  Brilliant, elliptical girdle; very pale blue-green; 3.135 carats; 10 by 9 by	No. No. No.	781 783 779 791
Connecticut.  Litchfield County:  Briolette, heart-shaped girdle; blue-green; 40.44 carats; 20 by 21 by 16 mm.  Brilliant, circular girdle; very pale green; 1.48 carats; 8 by 6 mm. Gift of New England Mining Company.  Brilliant, circular girdle; pale green; 1.119 carats; 7 by 5 mm. Gift of New England Mining Company.  Portland, Middlesex County:  Brilliant, rectangular girdle; deep blue-green; 14.26 carats; 17 by 15 by 10 mm.  Maine.  Paris, Oxford County:  Brilliant, rectangular girdle; colorless; 0.989 carat; 7 by 5.5 by 5 mm  Stoneham, Oxford County:  Brilliant, elliptical girdle; very pale blue-green; 3.135 carats; 10 by 9 by 7 mm.	No. No. No.	781 783 779 791 789
Connecticut.  Litchfield County:  Briolette, heart-shaped girdle; blue-green; 40.44 carats; 20 by 21 by 16 mm.  Brilliant, circular girdle; very pale green; 1.48 carats; 8 by 6 mm. Gift of New England Mining Company.  Brilliant, circular girdle; pale green; 1.119 carats; 7 by 5 mm. Gift of New England Mining Company.  Portland, Middlesex County:  Brilliant, rectangular girdle; deep blue-green; 14.26 carats; 17 by 15 by 10 mm.  Maine.  Paris, Oxford County:  Brilliant, rectangular girdle; colorless; 0.989 carat; 7 by 5.5 by 5 mm  Stoneham, Oxford County:  Brilliant, elliptical girdle; very pale blue-green; 3.135 carats; 10 by 9 by 7 mm.  Brilliant, rectangular girdle; pale blue-green; 1.045 carats; 7 by 6 by 5 mm  Massachusetts.	No. No. No.	781 783 779 791 789
Connecticut.  Litchfield County:  Briolette, heart-shaped girdle; blue-green; 40.44 carats; 20 by 21 by 16 mm.  Brilliant, circular girdle; very pale green; 1.48 carats; 8 by 6 mm. Gift of New England Mining Company.  Brilliant, circular girdle; pale green; 1.119 carats; 7 by 5 mm. Gift of New England Mining Company.  Portland, Middlesex County:  Brilliant, rectangular girdle; deep blue-green; 14.26 carats; 17 by 15 by 10 mm.  Maine.  Paris, Oxford County:  Brilliant, rectangular girdle; colorless; 0.989 carat; 7 by 5.5 by 5 mm  Stoneham, Oxford County:  Brilliant, elliptical girdle; very pale blue-green; 3.135 carats; 10 by 9 by 7 mm.  Brilliant, rectangular girdle; pale blue-green; 1.045 carats; 7 by 6 by 5 mm.  Massachusetts.  Fitchburg, Worcester County:	No. No. No. No.	781 783 779 791 789 790
Connecticut.  Litchfield County: Briolette, heart-shaped girdle; blue-green; 40.44 carats; 20 by 21 by 16 mm.  Brilliant, circular girdle; very pale green; 1.48 carats; 8 by 6 mm. Gift of New England Mining Company.  Brilliant, circular girdle; pale green; 1.119 carats; 7 by 5 mm. Gift of New England Mining Company.  Portland, Middlesex County: Brilliant, rectangular girdle; deep blue-green; 14.26 carats; 17 by 15 by 10 mm.  Maine.  Paris, Oxford County: Brilliant, rectangular girdle; colorless; 0.989 carat; 7 by 5.5 by 5 mm.  Stoneham, Oxford County: Brilliant, elliptical girdle; very pale blue-green; 3.135 carats; 10 by 9 by 7 mm.  Brilliant, rectangular girdle; pale blue-green; 1.045 carats; 7 by 6 by 5 mm.  Massachusetts.  Fitchburg, Worcester County: Trap, rectangular girdle; pale green; 0.889 carat; 7 by 6 by 4 mm	No. No. No. No.	781 783 779 791 789
Connecticut.  Litchfield County:  Briolette, heart-shaped girdle; blue-green; 40.44 carats; 20 by 21 by 16 mm.  Brilliant, circular girdle; very pale green; 1.48 carats; 8 by 6 mm. Gift of New England Mining Company.  Brilliant, circular girdle; pale green; 1.119 carats; 7 by 5 mm. Gift of New England Mining Company.  Portland, Middlesex County:  Brilliant, rectangular girdle; deep blue-green; 14.26 carats; 17 by 15 by 10 mm.  Maine.  Paris, Oxford County:  Brilliant, rectangular girdle; colorless; 0.989 carat; 7 by 5.5 by 5 mm  Stoneham, Oxford County:  Brilliant, elliptical girdle; very pale blue-green; 3.135 carats; 10 by 9 by 7 mm.  Brilliant, rectangular girdle; pale blue-green; 1.045 carats; 7 by 6 by 5 mm.  Massachusetts.  Fitchburg, Worcester County:	No. No. No. No.	781 783 779 791 789 790
Connecticut.  Litchfield County: Briolette, heart-shaped girdle; blue-green; 40.44 carats; 20 by 21 by 16 mm.  Brilliant, circular girdle; very pale green; 1.48 carats; 8 by 6 mm. Gift of New England Mining Company.  Brilliant, circular girdle; pale green; 1.119 carats; 7 by 5 mm. Gift of New England Mining Company.  Portland, Middlesex County: Brilliant, rectangular girdle; deep blue-green; 14.26 carats; 17 by 15 by 10 mm.  Maine.  Paris, Oxford County: Brilliant, rectangular girdle; colorless; 0.989 carat; 7 by 5.5 by 5 mm.  Stoneham, Oxford County: Brilliant, elliptical girdle; very pale blue-green; 3.135 carats; 10 by 9 by 7 mm.  Brilliant, rectangular girdle; pale blue-green; 1.045 carats; 7 by 6 by 5 mm.  Massachusetts.  Fitchburg, Worcester County: Trap, rectangular girdle; pale green; 0.889 carat; 7 by 6 by 4 mm.  Brilliant, circular girdle; pale yellow-green; 0.745 carat; 6 by 4 mm.	No. No. No. No.	781 783 779 791 789 790
Connecticut.  Litchfield County: Briolette, heart-shaped girdle; blue-green; 40.44 carats; 20 by 21 by 16 mm.  Brilliant, circular girdle; very pale green; 1.48 carats; 8 by 6 mm. Gift of New England Mining Company.  Brilliant, circular girdle; pale green; 1.119 carats; 7 by 5 mm. Gift of New England Mining Company.  Portland, Middlesex County: Brilliant, rectangular girdle; deep blue-green; 14.26 carats; 17 by 15 by 10 mm.  Maine.  Paris, Oxford County: Brilliant, rectangular girdle; colorless; 0.989 carat; 7 by 5.5 by 5 mm.  Stoneham, Oxford County: Brilliant, elliptical girdle; very pale blue-green; 3.135 carats; 10 by 9 by 7 mm.  Brilliant, rectangular girdle; pale blue-green; 1.045 carats; 7 by 6 by 5 mm.  Massachusetts.  Fitchburg, Worcester County: Trap, rectangular girdle; pale green; 0.889 carat; 7 by 6 by 4 mm.  Brilliant, circular girdle; pale yellow-green; 0.745 carat; 6 by 4 mm.  Royalston, Worcester County:	No. No. No. No.	781 783 779 791 789 790
Connecticut.  Litchfield County: Briolette, heart-shaped girdle; blue-green; 40.44 carats; 20 by 21 by 16 mm.  Brilliant, circular girdle; very pale green; 1.48 carats; 8 by 6 mm. Gift of New England Mining Company.  Brilliant, circular girdle; pale green; 1.119 carats; 7 by 5 mm. Gift of New England Mining Company.  Portland, Middlesex County: Brilliant, rectangular girdle; deep blue-green; 14.26 carats; 17 by 15 by 10 mm.  Maine.  Paris, Oxford County: Brilliant, rectangular girdle; colorless; 0.989 carat; 7 by 5.5 by 5 mm.  Stoneham, Oxford County: Brilliant, elliptical girdle; very pale blue-green; 3.135 carats; 10 by 9 by 7 mm.  Brilliant, rectangular girdle; pale blue-green; 1.045 carats; 7 by 6 by 5 mm.  Massachusetts.  Fitchburg, Worcester County: Trap, rectangular girdle; pale green; 0.889 carat; 7 by 6 by 4 mm.  Brilliant, circular girdle; pale yellow-green; 0.745 carat; 6 by 4 mm.	No. No. No. No. No. No.	781 783 779 791 789 790

#### North Carolina.

Asheville, Buncombe County:		
Step-brilliant, rectangular girdle; blue-green; 2.86 carats; 10 by 8 by		
7 mm	No.	777
Mitchell County:		
Cabochon, elliptical girdle; cloudy blue; 7.42 carats; 17 by 10 by 6 mm.		
Gift of J. K. Bruner	No.	778
Brilliant, circular girdle; blue-green; 7.617 carats; 13 by 9 mm. Isaac		
Lea collection	No.	746
Brilliant, circular girdle; blue-green; 5.124 carats; 11 by 8 mm. Isaac		
Les collection.	No.	747
Brilliant, circular girdle; blue-green; 2.87 carats; 9 by 6.5 mm. Isaac		• • • •
Les collection	Nο	748
Brilliant, circular girdle; blue-green; 2.036 carats; 8 by 6 mm. Isaac	110.	110
	N.	740
Lea collection.	NO.	749
Brilliant, circular girdle; blue-green; 1.52 carats; 8 by 6 mm. Isaac	3.7	
Lea collection.	No.	750
Brilliant, circular girdle; blue-green; 1.115 carats; 7 by 5 mm.		
Isaac Lea collection	No.	751
Brilliant, circular girdle; blue-green; 1.038 carats; 7 by 5 mm. Isaac		
Lea collection	No.	752
Brilliant, circular girdle; blue-green; 0.88 carat; 6 by 4.5 mm. Isaac		
Lea collection	No.	753
Brilliant, circular girdle; blue-green; 0.726 carat; 6 by 4 mm. Isaac		
Lea collection	No.	754
Brilliant, circular girdle; blue-green; 0.66 carat; 6 by 4 mm. Isaac		
Lea collection	No.	755
Brilliant, circular girdle; blue-green; 0.4 carat; 5 by 3 mm. Isaac		
Lea collection	No	736
	110.	100
Mount Mitchell, Yancey County:		
Step-brilliant, rectangular girdle; deep green-blue; 9.55 carats; 14 by		
12 by 10 mm. Isaac Lea collection	No.	776
Yancey County, Ray's Mica Mine:		
Brilliant, circular girdle; pale green-blue; 6.44 carats; 12 by 8 mm		775
Brilliant, circular girdle; pale blue-green; 2.035 carats; 9 by 5 mm		757
Brilliant, square girdle; pale green-yellow; 1.824 carats; 8 by 6 mm	No.	758
Brilliant, circular girdle; pale blue-green; 1.32 carats; 7 by 5 mm	No.	762
Brilliant, circular girdle; pale green; 1.056 carats; 7 by 5 mm	No.	765
Brilliant, circular girdle; pale blue-green; 0.999 carat; 6.5 by 5 mm	No.	766
Brilliant, circular girdle; pale blue-green; 0.87 carat; 6 by 5 mm		767
Brilliant, circular girdle; pale green; 0.72 carat; 6 by 4 mm		768
Brilliant, circular girdle; pale green; 0.60 carat; 5 by 4 mm		769
Brilliant, circular girdle; pale green; 0.51 carat; 5 by 4 mm		770
Brilliant, circular girdle; pale green; 0.335 carat; 5 by 3 mm		771
Brilliant, circular girdle; very pale green; 0.26 carat; 4 by 3 mm		772
		773
Brilliant, square girdle; green-blue; 0.205 carat; 3.5 by 2.5 mm		
Brilliant, circular girdle; green-yellow; 0.175 carat; 3.5 by 2 mm	No.	7/4
LOCALITY NOT RECORDED.		
Step-brilliant, elliptical girdle; pale green; 4 carats; 12.5 by 10 by 6 mm.		
Isaac Lea collection	No	720
Step-brilliant, elliptical girdle; pale green; 3.365 carats; 12 by 9 by 5 mm.	110.	, 20
	Ν·	701
Isaac Lea collection	NO.	721
Step-brilliant, elliptical girdle; pale blue-green; 1.982 carats; 9 by 7 by	NT.	70"
4 mm	NO.	727

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Step-brilliant, elliptical girdle; pale green; 1.737 carats; 10 by 7 by 4 mm.  Isaac Lea collection	No.	722
Brilliant, circular girdle; pale green; 1.265 carats; 7 by 4 mm		728
Isaac Lea collection		724
Isaac Lea collection	No.	723
Brilliant, circular girdle; pale green; 1.159 carats; 7 by 4 mm. Isaac Lea		700
collection	No.	726 730
Step-brilliant, rectangular girdle; 0.907 carat; 10 by 6 by 3 mm. Isaac Lea		730
collection		725
Brilliant, circular girdle; pale green; 0.838 carat; 7 by 4 mm	No.	729
Step-brilliant, elliptical girdle; blue-green; 0.26 carat; 6 by 4 by 2 mm		731
BERYL, variety EMERALD.		
UNITED STATES.		
North Carolina.		
Cabochon of emerald matrix, elliptical girdle; green and white mottled		
3.1 carats; 12 by 8 by 5 mm. Gift of Passmore Gem Company	No.	1650
Mitchell County:  Cabochon of emerald matrix, elliptical girdle; green and white mot		
tled; 38.15 carats; 28 by 21 by 9 mm		1574
Stony Point, Alexander County:  Twenty-five small gems, step, square and rectangular girdles; one step		
brilliant, circular girdle; bright green; total weight 5.96 carats; aver		
age size, 4 by 3.5 by 3 mm. Isaac Lea collection		801
LOCALITY NOT RECORDED.		
Step, elliptical girdle; pale green; 12 by 11 by 7 mm. Set in a ring	No.	828
Step, rectangular girdle; green; 12 by 10 by 6 mm. Set in a ring		
Table, rectangular girdle; deep green; 1.405 carata; 8 by 6 by 4 mm		
Step-brilliant, elliptical girdle; green; 0.697 carat; 6.5 by 6 by 3 mm		
Step, rectangular girdle; green; 0.52 carat; 6 by 5 by 3 mm	. No.	796

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Polished pebble, pear-shaped girdle; green; 4.87 carats; 14 by 7 mm..... No. 797

Composition.—Sodium beryllium phosphate, NaBePO.

Three small stones, step-brilliant, one irregular, one rectangular, one square

Crystallization.—Orthorhombic.

Color.—Colorless.

Luster.—Vitreous; transparent.

Hardness.—6; not very durable.

Specific gravity.—2.85  $\pm 0.05$ .

Optical properties.—Mean refractive index, 1.56; double refraction moderate, 0.01; optically biaxial, negative.

The mineral can be distinguished with certainty from other precious stones which resemble it only by chemical tests. It occurs in pegmatite, like beryl and tourmaline, and was first discovered among the

4555-22-3

disintegrated material of a granitic vein at Stoneham, Maine. It is not much used as a precious stone and is cut chiefly as a matter of scientific interest.

#### LIST OF SPECIMENS.

#### UNITED STATES.

#### Maine.

Stoneham, Oxford County:		
Brilliant, square girdle; colorless; 5 carats; 11 by 8 mm	No.	<b>12</b> 3
Step-brilliant, square girdle; colorless; 3.86 carats; 10 by 7 mm	No.	424
Brilliant, square girdle; colorless; 3.338 carats; 9 by 7.5 mm	No. 4	<b>£</b> 25
Bloodstone.—See under Chalcedony.		

#### CALAMINE.

Composition.—Basic zinc metasilicate (ZnOH)₂(SiO₃).

Crystallization.—Orthorhombic; hemimorphic; habit usually columnar-radiated.

Color.—White when pure, but often green or blue owing to the presence of admixed copper carbonates.

Luster.—Vitreous or somewhat silky; translucent.

Hardness.—5; not very durable.

Specific gravity.— $3.45 \pm 0.05$ .

Optical properties.—Mean refractive index 1.62; double refraction strong, 0.02; optically biaxial, positive.

Calamine may be distinguished from most other minerals which resemble it by softness and solubility, being readily attacked by dilute hydrochloric acid, with the formation of gelatinous silica. From smithsonite, which is likewise attacked, it is distinguished by lack of effervescence. It occurs as an alteration product of sulphide zinc ore in deposits above the permanent water level and it is sometimes cut cabochon and used for scarfpins, etc., but the value little exceeds the cost of cutting.

#### LIST OF SPECIMENS.

#### MEXICO (DISTRICT OF GALEANA, SIERRA MADRE, GUERRERO).

Cabochon, elliptical girdle; blue clouded with white; 26.43 carats; 23 by 17 by 12 mm. Gift of Charles H. Beers	No 1252
Cabochon, elliptical girdle; blue banded with white; 16.49 carats; 23 by 13	110. 1202
by 6.5 mm. Gift of Charles H. Beers	No. 1253
Cabochon, elliptical girdle; blue mottled with white; 10.64 carats; 18 by	
12.5 by 6 mm. Gift of Charles H. Beers	
Cabochon, elliptical girdle; blue with curved lines of white; 8.79 carats;	
16 by 13 by 5 mm. Gift of Charles H. Beers	
Cabochon, elliptical girdle; blue banded with white; 8.69 carats; 16 by 12	
by 5 mm. Gift of Charles H. Beers	
Cabochon, elliptical girdle; blue with curved lines of white; 4.825 carats;	
15 by 11 by 3 mm. Gift of Charles H. Beers	No. 1257

#### CALCITE and ARAGONITE.

Calcium carbonate occurs in nature under a great variety of forms which are mainly quite unsuited for gem purposes, though widely used in ornamentation (see under Coral and Supplemental Collections). Occasional forms are cut as souvenirs or as of local interest. A few such are here included.

#### LIST OF SPECIMENS.

#### SPAIN (ROCK OF GIBRALTAR.)

Polished plate of stalagmitic calcite; elliptical girdle; banded light and dark brown; 48.2 carats; 38 by 30 by 5 mm. Gift of Rev. Alexander McDonald. No. 368

#### UNITED STATES.

	rnia.

Colusa County:
Cabochon, rectangular girdle, of aragonite; light and dark brown; 22.08
carats; 27 by 14 by 7 mm
WEST INDIES.
Cameo, "Departure of the hunter"; elliptical girdle; white on light brown
base; 49 by 39 mm (fig. 1)
Cameo, "Winged angel"; elliptical girdle; white on light brown base; 45 by
37 mm
Cameo, "Return of the hunter";
elliptical girdle; white on
light brown base; 42 by 36mm. No. 1504
Cameo, head of Jupiter; ellip-
tical girdle; white on light
brown base; 35 by 30 mm No. 1505
Cameo, kneeling child with
cross; elliptical girdle; white
on light brown base; 31 by 24
mm
two representing bacchantes
and one Flora; white; oval
girdles; 36 by 22, 20 by 17, 19 Fig. 1.—Shell cameo.
by 16 mm
Conch shell with cameo carving, white and pink
Conch shell bracelet in form of a serpent; white and pink
Conch shell brooch, carved cupid; pink
Conch shell brooch; fish; brown and white
LOCALITY NOT RECORDED.
Cameo, two faces; rectangular; white on light brown base
Californite.—See under Vesuvianite.
Cameo.—See under Calcite and Aragonite (shell cameo), and
Quartz, variety Onyx.
Carnelian.—See under Chalcedony.
Catalinite.—See under Quartz.
Cat's-eye.—See under Chrysoberyl and Quartz.

#### CHALCEDONY.

Varieties.—Here are included the cryptocrystalline and amorphous, often more or less impure, varieties of silica comprised under the names agate, bloodstone, carnelian, chrysoprase, jasper, prase, etc. The term agate includes the banded forms (fig. 2); carnelian, the red; chrysoprase, the green; bloodstone, a compact, dark, opaque variety with blood red spots; jasper, a great range of opaque impure forms of a red, yellow brown, or black color, the varying hues being due mainly to iron and manganese oxides. The silicified wood of the Arizona "Fossil Forest" is largely chalcedony in the cryptocrystalline form of jasper; onyx is a variety of agate with straight alter-



Fig. 2.—Banded agate.

nating bands of light and dark; moss agate, a milky or colorless form with dendritic markings of manganese oxide resembling moss or other plant growth. Plasma and prase are green in color, and sard, or sardonyx, of a golden to blood red color.

These stones are cut only cabochon or flat, unfacetted forms, and are valued according to their varying beauty, common agate and jasper being the cheaper forms. The majority of agates sold in the shops are from Brazil, and are cut and artificially colored in Germany.

The moss agates of Wyoming are found, according to Mr. C. J. Hares, of the United States Geological Survey, scattered over the surface of the ground in several townships of Fremont County and along the Sweetwater Valley. The agate pebbles range in size from 2 inches or more in diameter and are usually well rounded. The good specimens are uncommon, being associated with a great many

worthless pebbles such as black and red jaspers, quartzite or white milky quartz, or chalcedony. The agates range from an opaque white and gray to highly translucent gray with black, dark brown, reddish to yellow-brown dendritic markings. Those with the black and dark brown markings are the most common. They show great variation in size and delicacy of pattern. Some are small rounded tufts, too dense to show individual lines, and others are as much as 2 or 3 millimeters across, exhibiting very delicate moss-like or seaweed-like markings. The original source of the gravel is supposed to have been the White River formation of the vicinity, which is of Oligocene age. (See further under Quartz.)

### LIST OF SPECIMENS.

### CHALCEDONY, common.

### GERMANY.

<del></del>		
Two gems, cabochon, one rectangular, one elliptical; pale cloudy gray; 41 by 29 by 5, 19 by 16 by 6 mm. Gift of George F. Kunz	No.	803
INDIA.		
Six stones, cabochon, three elliptical, two elongated octagon, one pear-shaped; 36 by 27 by 8 to 18 by 15 by 6 mm	No.	802
UNITED STATES.		
California.		
	No.	812
Cabochon, pear-shaped girdle; gray and green, mottled; 28 by 21 by 8 mm	No.	813
Colorado.		
Cabochon, elliptical guidle; translucent with red color; 2.8 carats; 11 by 7 by 5 mm. (St. Stephen stone). Gift of J. B. Endicott	No	815
Virginia.		
Fairfax, Fairfax County: Cabochon, circular girdle; pale cloudy gray; 10 by 7 mm	No.	804
LOCALITY NOT RECORDED.		
Twelve stones, cabochon and tabular, elliptical girdles; cloudy browngray; 46 by 35 by 4 mm. to 20 by 15 by 3 mm	No.	807
pendant; pale gray; 25 by 20 by 6, 26 by 17 by 5, 42 by 12, 25 by 12 mm Four stones, cabochon, elliptical girdle; artificially colored yellow, three	No.	546
banded; 38 by 29 by 8 mm. to 23 by 17 by 7 mm	No	543
Five stones, cabochon and table, elliptical and pear-shaped girdles; artificially colored yellow; 32 by 24 by 7 mm., 19 by 10 mm	No.	806

Five stones, cabochon, tabular, elliptical, rectangular, and diamond-shaped girdles; artificially colored gray, gray-green, and red; 29 by 23		
by 12 mm. to 24 by 18 by 5 mm		
mm. to 23 by 11 by 3 mm		
by 6 mm., 18 by 15 by 6 mm		
by 16 mm	No.	809
Sixty-two stones, variously cut; pale gray		
Isaac Lea collection		
collection	I/ O•	810
CHALCEDONY, variety AGATE.		
BRAZIL.		
Three circular disks; dark brown to black, with rings of pale blue and white (artificially colored); average diameter, 43 mm. Bequest of William H. Forwood	No.	429
GERMANY.		
Oberstein: Table, rectangular girdle (charm); black and white banded; 29 by 25		
	No.	533
Cabochon, elliptical girdle; black and white banded; 29 by 25 by 10 mm.	No.	521
Two pieces, tabular, rectangular girdle; brown and white banded; 29		
by 25 by 5 mm., 28 by 25 by 5 mm.		
Button, circular; brown banded; 26 by 4 mm. Isaac Lea collection Four pieces, cabochon, heart-shaped and elliptical girdles; brown,		
banded; 36 by 32 by 6 mm., 25 by 18 by 4 mm	No.	519
banded; 37 by 29 by 3 mm. to 29 by 23 by 7 mm	No.	520
mm. to 40 by 26 by 3 mm	No.	530
Four pieces, cabochon, three diamond-shaped, one elongated octagon girdles; various colors; 29 by 18 by 5 mm., 26 by 15 by 5 mm	No.	522
Five slabs, rectangular; blue, green, and brown, banded, artificially colored; 73 by 30 mm. to 73 by 25 mm. Gift of George F. Kunz	No.	1482
Five pieces, two cabochon, three tabular, elliptical girdle; gray and brown, banded, one dull red and brown; 30 by 24 by 6 mm., to 24 by 19 by 5 mm	No	534
Seven pieces, table, elliptical and circular girdles; dark brown, banded;		
54 by 37 by 5 to 34 by 24 by 7 mm	.10.	ωı
shaped girdles; black or dark brown and white banded; various sizes	No-	536
Ten pieces, tabular, elliptical girdle; gray and red banded; 38 by 30 by		
6 mm. to 26 by 18 by 2 mm	No.	532

¹It is probable that a considerable number of stones accredited to this locality were originally from other sources and taken to Oberstein for cutting.

Oberstein—Continued.  Ten pendant or club-shaped pieces; very dark brown to black, 66 to 35 mm. in length  Ten pieces, various cuts, pendant or pear-shaped girdles; brown banded; 49 by 10 to 18 by 8 mm	No.	
Ring; gray and brown; 25 mm. diameter. Isaac Lea collection	No.	1479
Elliptical disk; pale red and white, banded; 25 by 20 by 4 mm	No.	1480
UNITED STATES.		
Lake Superior.		
Tabular, elliptical girdle; gray mottled with red; 42 by 28 by 4 mm. Isaac	<b>N</b> T -	1 4mm
Lea collection	No.	1477
Michigan.		
Agate Bay, Lake Superior:  Ellipsoid, white clouded with light brown; mounted as a charm; 25 by 21 by 17 mm. Isaac Lea collection	No.	1478
LOCALITY NOT RECORDED.		
Slab, rectangular; dark brown; 55 by 39 by 5 mm. Gift of George F. Kunz  Table, rectangular girdle; blue, artificially colored; banded with white; 38 by 19 by 4 mm		
Ring or armlet; red, yellow, and white banded; 87 mm. diameter	No.	1642 1485
Disk, rectangular; red-brown and gray, banded; 39 by 21 by 2 mm  Three stones, cabochon, circular girdle; gray and white, red-brown and white; gray and black; 11 by 6, 8 by 5, and 8 by 4 mm  Two slabs, rectangular girdle; pink, cloudy; 71 by 42 by 4 mm., 69 by 41 by	No.	444 453
3 mm. Gift of Col. J. G. Totten		
Nine stones, various cuts; gray, banded; 41 by 14 by 2.5 mm. to 15 by 12		
by 2 mm.  Ten stones, various cuts; brown and red, mottled; 60 by 19 by 3 mm. to 27 by 9 mm.  Twelve stones, tabular, various girdles and colors.  Fourteen stones, various cuts and colors; 40 by 29 by 10 mm. to 23 by 10 by 3 mm. Isaac Lea collection.  Three pendants, table, eliptical girdle; various colors, banded; 45 by 36 by 5 and 43 by 33 by 5 mm. Gift of A. E. Heighway.	No. : No.	1489 518 517
CHALCEDONY, variety BLOODSTONE.		
INDIA.		
Three stones, cabochon and tabular, rectangular girdle; blue-green with red spots; 42 by 14 by 5, 35 by 14 by 4, and 28 by 26 by 3 mm		
the letter H; green with red spots; 19 by 15 by 4 and 21 by 14 by 3 mm	No.	1462

### LOCALITY NOT RECORDED.

Cabochon, circular girdle; dark green with red and yellow spots; 58 by 6 mm.		
Gift of George F. Kunz	No.	L46 <b>3</b>
Cabochon, elliptical girdle; dark green with few red spots; 40 by 30 by 6 mm. Table, rectangular girdle; dark green with very few red spots; 25 by 18 by	No.	1464
5 mm	No.	1465
Table, circular girdle; dark and pale yellow-green, few red spots; 25 by		
3 mm	No.	1466
Table, circular girdle; dark blue-green with red spots; 19 by 3 mm. (fig. 8,		
pl. 7)	No.	1467
12 and 5 by 3 mm	N ₀	1469
Cabochon, elliptical girdle; dark green with red markings; 41 by 35 by 5.5	110.	1100
mm. Gift of Mrs. Spencer F. Baird	No.	1469
Table, circular girdle; streaked dark blue-green and red; 27 by 2 mm		
Table, one elliptical and four shield-shaped girdles; dark green with few red		
spots: 18 by 10 by 2 mm. and 10 by 10 by 2.5 mm. Isaac Lea collection	No.	1471
CHALCEDONY, variety CARNELIAN.		
GERMANY.		
Bracelet of 6 buttons and 12 beads; red banded. Isaac Lea collection	No	1849
Oberstein:	140.	1020
Table, rectangular girdle; red; 24 by 19 mm	No.	503
PALESTINE.		
Table, elliptical girdle; red; 15 by 13 by 3 mm. Has Hebrew characters on it	N.	500
on it	140.	002
LOCALITY NOT RECORDED.		
Tabular, elliptical girdle; deep brown-red; 53 by 42 mm	No.	506
Tabular, elliptical girdle; deep brown-red; 53 by 42 mm	No.	510
Tabular, elliptical girdle; deep brown-red; 53 by 42 mm	No.	510 1648
Tabular, elliptical girdle; deep brown-red; 53 by 42 mm	No. No. No.	510 1648
Tabular, elliptical girdle; deep brown-red; 53 by 42 mm	No. No. No.	510 1648 1649
Tabular, elliptical girdle; deep brown-red; 53 by 42 mm	No. No. No.	510 1648 1649
Tabular, elliptical girdle; deep brown-red; 53 by 42 mm.  Tabular, circular girdle; red-brown; 50 by 5 mm.  Brooch, circular girdle; red; 39 mm. diameter. Gift of A. E. Heighway.  Pin bar; red; 65 mm. long. Gift of A. E. Heighway.  Three stones, cabochon, circular and elliptical girdles; red-brown; 20 by 3 and 19 by 11 by 5 mm.  Three stones, two disks, one table, rectangular girdles; red-brown; 44 by 34	No. No. No.	510 1648 1649 527
Tabular, elliptical girdle; deep brown-red; 53 by 42 mm	No. No. No.	510 1648 1649 527 526
Tabular, elliptical girdle; deep brown-red; 53 by 42 mm.  Tabular, circular girdle; red-brown; 50 by 5 mm.  Brooch, circular girdle; red; 39 mm. diameter. Gift of A. E. Heighway.  Pin bar; red; 65 mm. long. Gift of A. E. Heighway.  Three stones, cabochon, circular and elliptical girdles; red-brown; 20 by 3 and 19 by 11 by 5 mm.  Three stones, two disks, one table, rectangular girdles; red-brown; 44 by 34 by 3, 25 by 22 by 3, 18 by 15 by 5 mm.  Six stones, various cuts and girdles; 20 by 16 by 7 to 18 by 15 by 4 mm	No. No. No. No.	510 1648 1649 527 526 507
Tabular, elliptical girdle; deep brown-red; 53 by 42 mm.  Tabular, circular girdle; red-brown; 50 by 5 mm.  Brooch, circular girdle; red; 39 mm. diameter. Gift of A. E. Heighway.  Pin bar; red; 65 mm. long. Gift of A. E. Heighway.  Three stones, cabochon, circular and elliptical girdles; red-brown; 20 by 3 and 19 by 11 by 5 mm.  Three stones, two disks, one table, rectangular girdles; red-brown; 44 by 34 by 3, 25 by 22 by 3, 18 by 15 by 5 mm.  Six stones, various cuts and girdles; 20 by 16 by 7 to 18 by 15 by 4 mm  Six disks, elliptical girdle; brown-red; 55 by 44 by 11 to 31 by 25 by 7 mm  Six stones, tabular, elliptical and circular girdles; red, banded and mottled	No. No. No. No. No. No.	510 1648 1649 527 526 507 525
Tabular, elliptical girdle; deep brown-red; 53 by 42 mm.  Tabular, circular girdle; red-brown; 50 by 5 mm.  Brooch, circular girdle; red; 39 mm. diameter. Gift of A. E. Heighway  Pin bar; red; 65 mm. long. Gift of A. E. Heighway  Three stones, cabochon, circular and elliptical girdles; red-brown; 20 by 3 and 19 by 11 by 5 mm.  Three stones, two disks, one table, rectangular girdles; red-brown; 44 by 34 by 3, 25 by 22 by 3, 18 by 15 by 5 mm.  Six stones, various cuts and girdles; 20 by 16 by 7 to 18 by 15 by 4 mm  Six disks, elliptical girdle; brown-red; 55 by 44 by 11 to 31 by 25 by 7 mm  Six stones, tabular, elliptical and circular girdles; red, banded and mottled 53 by 45 by 4 to 38 by 28 by 5 mm	No. No. No. No. No. No.	510 1648 1649 527 526 507 525 509
Tabular, elliptical girdle; deep brown-red; 53 by 42 mm.  Tabular, circular girdle; red-brown; 50 by 5 mm.  Brooch, circular girdle; red; 39 mm. diameter. Gift of A. E. Heighway  Pin bar; red; 65 mm. long. Gift of A. E. Heighway  Three stones, cabochon, circular and elliptical girdles; red-brown; 20 by 3 and 19 by 11 by 5 mm.  Three stones, two disks, one table, rectangular girdles; red-brown; 44 by 34 by 3, 25 by 22 by 3, 18 by 15 by 5 mm.  Six stones, various cuts and girdles; 20 by 16 by 7 to 18 by 15 by 4 mm  Six disks, elliptical girdle; brown-red; 55 by 44 by 11 to 31 by 25 by 7 mm  Six stones, tabular, elliptical and circular girdles; red, banded and mottled 53 by 45 by 4 to 38 by 28 by 5 mm  Six stones, various cuts; red, mottled and banded.	No. No. No. No. No. No. No. No. No.	510 1648 1649 527 526 507 525 509
Tabular, elliptical girdle; deep brown-red; 53 by 42 mm.  Tabular, circular girdle; red-brown; 50 by 5 mm.  Brooch, circular girdle; red; 39 mm. diameter. Gift of A. E. Heighway  Pin bar; red; 65 mm. long. Gift of A. E. Heighway  Three stones, cabochon, circular and elliptical girdles; red-brown; 20 by 3 and 19 by 11 by 5 mm.  Three stones, two disks, one table, rectangular girdles; red-brown; 44 by 34 by 3, 25 by 22 by 3, 18 by 15 by 5 mm.  Six stones, various cuts and girdles; 20 by 16 by 7 to 18 by 15 by 4 mm  Six disks, elliptical girdle; brown-red; 55 by 44 by 11 to 31 by 25 by 7 mm  Six stones, tabular, elliptical and circular girdles; red, banded and mottled 53 by 45 by 4 to 38 by 28 by 5 mm.  Six stones, various cuts; red, mottled and banded.  Seven stones, tabular, rectangular girdle; red; 45 by 30 by 9 to 15 by 13 by	No. No. No. No. No. No. No. No.	510 1648 1649 527 526 507 525 509 511
Tabular, elliptical girdle; deep brown-red; 53 by 42 mm.  Tabular, circular girdle; red-brown; 50 by 5 mm.  Brooch, circular girdle; red; 39 mm. diameter. Gift of A. E. Heighway  Pin bar; red; 65 mm. long. Gift of A. E. Heighway  Three stones, cabochon, circular and elliptical girdles; red-brown; 20 by 3 and 19 by 11 by 5 mm.  Three stones, two disks, one table, rectangular girdles; red-brown; 44 by 34 by 3, 25 by 22 by 3, 18 by 15 by 5 mm.  Six stones, various cuts and girdles; 20 by 16 by 7 to 18 by 15 by 4 mm  Six disks, elliptical girdle; brown-red; 55 by 44 by 11 to 31 by 25 by 7 mm  Six stones, tabular, elliptical and circular girdles; red, banded and mottled 53 by 45 by 4 to 38 by 28 by 5 mm.  Six stones, various cuts; red, mottled and banded.  Seven stones, tabular, rectangular girdle; red; 45 by 30 by 9 to 15 by 13 by 5 mm. Isaac Lea collection.	No. No. No. No. No. No. No. No. No.	510 1648 1649 527 526 507 525 509 511 514
Tabular, elliptical girdle; deep brown-red; 53 by 42 mm.  Tabular, circular girdle; red-brown; 50 by 5 mm.  Brooch, circular girdle; red; 39 mm. diameter. Gift of A. E. Heighway  Pin bar; red; 65 mm. long. Gift of A. E. Heighway  Three stones, cabochon, circular and elliptical girdles; red-brown; 20 by 3 and 19 by 11 by 5 mm.  Three stones, two disks, one table, rectangular girdles; red-brown; 44 by 34 by 3, 25 by 22 by 3, 18 by 15 by 5 mm.  Six stones, various cuts and girdles; 20 by 16 by 7 to 18 by 15 by 4 mm  Six disks, elliptical girdle; brown-red; 55 by 44 by 11 to 31 by 25 by 7 mm  Six stones, tabular, elliptical and circular girdles; red, banded and mottled 53 by 45 by 4 to 38 by 28 by 5 mm.  Six stones, various cuts; red, mottled and banded.  Seven stones, tabular, rectangular girdle; red; 45 by 30 by 9 to 15 by 13 by 5 mm. Isaac Lea collection.  Seven stones, various fancy cuts; red.	No. No. No. No. No. No. No. No. No.	510 1648 1649 527 526 507 525 509 511 514
Tabular, elliptical girdle; deep brown-red; 53 by 42 mm.  Tabular, circular girdle; red-brown; 50 by 5 mm.  Brooch, circular girdle; red; 39 mm. diameter. Gift of A. E. Heighway  Pin bar; red; 65 mm. long. Gift of A. E. Heighway  Three stones, cabochon, circular and elliptical girdles; red-brown; 20 by 3 and 19 by 11 by 5 mm.  Three stones, two disks, one table, rectangular girdles; red-brown; 44 by 34 by 3, 25 by 22 by 3, 18 by 15 by 5 mm.  Six stones, various cuts and girdles; 20 by 16 by 7 to 18 by 15 by 4 mm  Six disks, elliptical girdle; brown-red; 55 by 44 by 11 to 31 by 25 by 7 mm  Six stones, tabular, elliptical and circular girdles; red, banded and mottled 53 by 45 by 4 to 38 by 28 by 5 mm.  Six stones, various cuts; red, mottled and banded.  Seven stones, tabular, rectangular girdle; red; 45 by 30 by 9 to 15 by 13 by 5 mm. Isaac Lea collection.  Seven stones, various fancy cuts; red.  Eight stones, cabochon, elliptical girdle; red; 33 by 25 by 7 to 15 by 12 by	No. No. No. No. No. No. No. No. No.	510 1648 1649 527 526 507 525 509 511 514 529
Tabular, elliptical girdle; deep brown-red; 53 by 42 mm.  Tabular, circular girdle; red-brown; 50 by 5 mm.  Brooch, circular girdle; red; 39 mm. diameter. Gift of A. E. Heighway  Pin bar; red; 65 mm. long. Gift of A. E. Heighway  Three stones, cabochon, circular and elliptical girdles; red-brown; 20 by 3 and 19 by 11 by 5 mm.  Three stones, two disks, one table, rectangular girdles; red-brown; 44 by 34 by 3, 25 by 22 by 3, 18 by 15 by 5 mm.  Six stones, various cuts and girdles; 20 by 16 by 7 to 18 by 15 by 4 mm  Six stones, tabular, elliptical and circular girdles; red, banded and mottled 53 by 45 by 4 to 38 by 28 by 5 mm.  Six stones, various cuts; red, mottled and banded.  Seven stones, tabular, rectangular girdle; red; 45 by 30 by 9 to 15 by 13 by 5 mm. Isaac Lea collection.  Seven stones, various fancy cuts; red.  Eight stones, cabochon, elliptical girdle; red; 33 by 25 by 7 to 15 by 12 by 7 mm. Isaac Lea collection.	No.	510 1648 1649 527 526 507 525 509 511 514 529
Tabular, elliptical girdle; deep brown-red; 53 by 42 mm.  Tabular, circular girdle; red-brown; 50 by 5 mm.  Brooch, circular girdle; red; 39 mm. diameter. Gift of A. E. Heighway  Pin bar; red; 65 mm. long. Gift of A. E. Heighway  Three stones, cabochon, circular and elliptical girdles; red-brown; 20 by 3 and 19 by 11 by 5 mm.  Three stones, two disks, one table, rectangular girdles; red-brown; 44 by 34 by 3, 25 by 22 by 3, 18 by 15 by 5 mm.  Six stones, various cuts and girdles; 20 by 16 by 7 to 18 by 15 by 4 mm  Six disks, elliptical girdle; brown-red; 55 by 44 by 11 to 31 by 25 by 7 mm  Six stones, tabular, elliptical and circular girdles; red, banded and mottled 53 by 45 by 4 to 38 by 28 by 5 mm.  Six stones, various cuts; red, mottled and banded  Seven stones, tabular, rectangular girdle; red; 45 by 30 by 9 to 15 by 13 by 5 mm. Isaac Lea collection.  Seven stones, various fancy cuts; red  Eight stones, cabochon, elliptical girdle; red; 33 by 25 by 7 to 15 by 12 by 7 mm. Isaac Lea collection  Eight stones, engraved, various girdles; pale yellow-red to deep brown-red 25 by 21 by 4 to 12 by 2 mm.	No.	510 1648 1649 527 526 507 525 509 511 514 529
Tabular, elliptical girdle; deep brown-red; 53 by 42 mm.  Tabular, circular girdle; red-brown; 50 by 5 mm.  Brooch, circular girdle; red; 39 mm. diameter. Gift of A. E. Heighway  Pin bar; red; 65 mm. long. Gift of A. E. Heighway  Three stones, cabochon, circular and elliptical girdles; red-brown; 20 by 3 and 19 by 11 by 5 mm.  Three stones, two disks, one table, rectangular girdles; red-brown; 44 by 34 by 3, 25 by 22 by 3, 18 by 15 by 5 mm.  Six stones, various cuts and girdles; 20 by 16 by 7 to 18 by 15 by 4 mm  Six disks, elliptical girdle; brown-red; 55 by 44 by 11 to 31 by 25 by 7 mm  Six stones, tabular, elliptical and circular girdles; red, banded and mottled 53 by 45 by 4 to 38 by 28 by 5 mm.  Six stones, various cuts; red, mottled and banded.  Seven stones, tabular, rectangular girdle; red; 45 by 30 by 9 to 15 by 13 by 5 mm. Isaac Lea collection.  Seven stones, various fancy cuts; red.  Eight stones, cabochon, elliptical girdle; red; 33 by 25 by 7 to 15 by 12 by 7 mm. Isaac Lea collection.  Eight stones, engraved, various girdles; pale yellow-red to deep brown-red 25 by 21 by 4 to 12 by 2 mm.  Fourteen stones, elliptical disks; pale red to red-brown; 27 by 20 by 6 to	No.	510 1648 1649 527 526 507 525 509 511 514 529 512 528
Tabular, elliptical girdle; deep brown-red; 53 by 42 mm.  Tabular, circular girdle; red-brown; 50 by 5 mm.  Brooch, circular girdle; red; 39 mm. diameter. Gift of A. E. Heighway  Pin bar; red; 65 mm. long. Gift of A. E. Heighway  Three stones, cabochon, circular and elliptical girdles; red-brown; 20 by 3 and 19 by 11 by 5 mm.  Three stones, two disks, one table, rectangular girdles; red-brown; 44 by 34 by 3, 25 by 22 by 3, 18 by 15 by 5 mm.  Six stones, various cuts and girdles; 20 by 16 by 7 to 18 by 15 by 4 mm  Six disks, elliptical girdle; brown-red; 55 by 44 by 11 to 31 by 25 by 7 mm  Six stones, tabular, elliptical and circular girdles; red, banded and mottled 53 by 45 by 4 to 38 by 28 by 5 mm.  Six stones, various cuts; red, mottled and banded.  Seven stones, tabular, rectangular girdle; red; 45 by 30 by 9 to 15 by 13 by 5 mm. Isaac Lea collection.  Eight stones, cabochon, elliptical girdle; red; 33 by 25 by 7 to 15 by 12 by 7 mm. Isaac Lea collection.  Eight stones, engraved, various girdles; pale yellow-red to deep brown-red 25 by 21 by 4 to 12 by 2 mm.  Fourteen stones, elliptical disks; pale red to red-brown; 27 by 20 by 6 to 17 by 14 by 6 mm. Isaac Lea collection.	No.	510 1648 1649 527 526 507 525 509 511 514 529 512 528
Tabular, elliptical girdle; deep brown-red; 53 by 42 mm.  Tabular, circular girdle; red-brown; 50 by 5 mm.  Brooch, circular girdle; red; 39 mm. diameter. Gift of A. E. Heighway  Pin bar; red; 65 mm. long. Gift of A. E. Heighway  Three stones, cabochon, circular and elliptical girdles; red-brown; 20 by 3 and 19 by 11 by 5 mm.  Three stones, two disks, one table, rectangular girdles; red-brown; 44 by 34 by 3, 25 by 22 by 3, 18 by 15 by 5 mm.  Six stones, various cuts and girdles; 20 by 16 by 7 to 18 by 15 by 4 mm  Six disks, elliptical girdle; brown-red; 55 by 44 by 11 to 31 by 25 by 7 mm  Six stones, tabular, elliptical and circular girdles; red, banded and mottled 53 by 45 by 4 to 38 by 28 by 5 mm.  Six stones, various cuts; red, mottled and banded.  Seven stones, tabular, rectangular girdle; red; 45 by 30 by 9 to 15 by 13 by 5 mm. Isaac Lea collection.  Seven stones, various fancy cuts; red.  Eight stones, cabochon, elliptical girdle; red; 33 by 25 by 7 to 15 by 12 by 7 mm. Isaac Lea collection.  Eight stones, engraved, various girdles; pale yellow-red to deep brown-red 25 by 21 by 4 to 12 by 2 mm.  Fourteen stones, elliptical disks; pale red to red-brown; 27 by 20 by 6 to 17 by 14 by 6 mm. Isaac Lea collection.  Fourteen intaglios and one cameo; very pale to dark red; 14 by 11 by 3 to 6.	No.	510 1648 1649 527 526 507 525 509 511 514 529 512 528
Tabular, elliptical girdle; deep brown-red; 53 by 42 mm.  Tabular, circular girdle; red-brown; 50 by 5 mm.  Brooch, circular girdle; red; 39 mm. diameter. Gift of A. E. Heighway  Pin bar; red; 65 mm. long. Gift of A. E. Heighway  Three stones, cabochon, circular and elliptical girdles; red-brown; 20 by 3 and 19 by 11 by 5 mm.  Three stones, two disks, one table, rectangular girdles; red-brown; 44 by 34 by 3, 25 by 22 by 3, 18 by 15 by 5 mm.  Six stones, various cuts and girdles; 20 by 16 by 7 to 18 by 15 by 4 mm  Six disks, elliptical girdle; brown-red; 55 by 44 by 11 to 31 by 25 by 7 mm  Six stones, tabular, elliptical and circular girdles; red, banded and mottled 53 by 45 by 4 to 38 by 28 by 5 mm.  Six stones, various cuts; red, mottled and banded.  Seven stones, tabular, rectangular girdle; red; 45 by 30 by 9 to 15 by 13 by 5 mm. Isaac Lea collection.  Eight stones, cabochon, elliptical girdle; red; 33 by 25 by 7 to 15 by 12 by 7 mm. Isaac Lea collection.  Eight stones, engraved, various girdles; pale yellow-red to deep brown-red 25 by 21 by 4 to 12 by 2 mm.  Fourteen stones, elliptical disks; pale red to red-brown; 27 by 20 by 6 to 17 by 14 by 6 mm. Isaac Lea collection.	No.	510 1648 1649 527 526 507 525 509 511 514 529 512 528 513

# CHALCEDONY, variety CHRYSOPRASE. SILESIA.

Cabochon, circular girdle; pale green; 51.29 carats; 24 by 13 mm
UNITED STATES.
Arizona,
Globe, Gila County:
Cabochon, elliptical girdle; dull green; 5.58 carats; 15 by 10 by 5 mm.;
Isaac Lea collection
. California.
Visalia, Tulare County:
Cabochon, elliptical girdle; green; 10 carats; 20 by 14 by 5 mm. Isaac
Lea collection (fig. 5, pl. 12)
Cabochon, circular girdle; green; 7.99 carats; 13 by 7 mm. Isaac Lea
collection
Cabochon, elliptical girdle; green; 6.25 carats; 13 by 10 by 7 mm. Isaac
Les collection
Cabochon, elliptical girdle; green; 4.97 carats; 12 by 9 by 7 mm. Isaac
Lea collection
Cabochon, elliptical girdle; green; 4.77 carats; 18 by 9 by 4 mm. Isaac
Lea collection
Cabochon, elliptical girdle; green; 4.175 carats; 12.5 by 9 by 6 mm No. 1423
Cabochon, circular girdle; green; 4.05 carats; 11 by 5 mm. Isaac Lea
collection
Cabochon, circular girdle; green; 2.28 carats; 8 by 5 mm. Isaac Lea
collection
Cabochon, circular girdle; green; 0.5 carats; 5 by 3 mm. Isaac Lea
collection
CHALCEDONY, variety JASPER.
EGYPT (NILE RIVER).
Two pieces, one cabochon, elliptical girdle, and one rectangular slab; brown,
mottled; 31 by 24 by 6 and 47 by 38 by 4 mm
ENGLAND (HERTFORDSHIRE).
Cabochon, circular girdles; brown, mottled; breastpin, 35 mm. diameter,
and two cuff buttons, 25 mm. diameter
sig two cun butwins, 25 mm. dismeter
INDIA.
Two disks, elliptical girdles; one mottled blue-green, red, and brown, one
red and green; 84 by 57 by 4 and 80 by 55 by 3.5 mm
SAXONY.
Ellipsoid, polished; red; 42 by 35 by 22 mm
, ,

SIBERIA.		
Tabular, elliptical girdle; green and red banded; 25 by 19 mm	No.	821
LOCALITY NOT RECORDED.		
Elliptical disk of "agate jasper"; red-brown with blue veins; 33 by 25 by 4 mm. (fig. 10, pl. 7)	No. No. No.	819 818
CHALCEDONY, variety MOSS AGATE.		
CHINA.		
Table, elliptical girdle; gray with green inclusions; 37 by 29 by 2 mm.		
Isaac Lea collection.	No.	437
INDIA.		
Two elliptical disks; cloudy gray with brown inclusions; 51 by 35 by 3 and 39 by 30 by 4.5 mm. (fig. 3)	No.	1490
Fig. 3,—Moss agates,		
Elliptical disk; gray with black inclusions; 47 by 31 by 3 mm. Isaac Lea collection (fig. 3)	No	419
Table, elliptical girdle; gray with green inclusions; 44 by 33 mm  Ninety-one small stones, cabochon, various girdles; gray with brown and red inclusions	No.	418
JAPAN.		
Five stones, one tabular, four cabochon; elliptical and circular girdles; gray; 34 by 22 by 3 to 10 by 5 mm. Isaac Lea collection	No.	<b>4</b> 27
UNITED STATES.		
Kansas.		
Eight small stones, cabochon, seven elliptical, one diamond-shaped girdle; cloudy gray with brown inclusions; total weight, 3.23 carats; 15 by 10 by 3 to 12 by 8 by 2 mm	No.	438

## Montana.

Glendive, Dawson County:		
Three gems, cabochon, elliptical girdles; cloudy gray with dark brown inclusions; 46 by 20 by 8, 35 by 15 by 3.5, and 26 by 12.5 by 4 mm.		
Isaac Lea collection		1491
Cabochon, pendant or pear-shaped girdle; cloudy gray with red-brown and dark brown inclusions; 62 by 35 by 5 mm. Isaac Lea collection.		1492
Wyoming.		
Fort Bridger, Uinta County:		
Cabochon, elliptical girdle; cloudy gray with black inclusions; 4.45 carats; 16 by 12 by 3.5 mm		432
Yellowstone National Park:  Table, rectangular girdle; cloudy gray with black inclusions; 6.22 carats;		
19 by 13 by 2.5 mm. Isaac Lea collection	Nο	431
Cabochon, elliptical girdle; cloudy gray, brown inclusions; two pieces, 7.66 and 7.42 carats; 20 by 14 by 4 mm.		
One cabochon and two tabular cut pieces, elliptical girdles; cloudy	210.	120
gray with brown inclusions; 16.46, 9.23, and 9.1 carats; 25 by 16 by		
6 and 26 by 17 by 2 mm	No.	428
LOCALITY NOT RECORDED.		
An armlet; lead gray and green; 85 mm. diameter	No.	459
Pendant, table, elliptical girdle; gray with green inclusions; 45 by 35 by 5		
mm. Gift of A. E. Heighway	No.	1647
Tabular, elliptical girdle; red-brown; 52 by 38 by 4 mm		454
Club-shaped piece; mottled red, brown, and gray; 43 by 10 mm		446
Tabular, elliptical girdle; mottled red, brown, and gray; 36 by 28 by 6 mm.		445
Tabular, elliptical girdle; mottled red, brown, and gray; 34 by 29 by 7 mm.		430
Cabochon, diamond-shaped girdle; red-brown; 27 by 20 by 5 mm		443
Disk, elliptical; mottled red-brown and gray; 22 by 18 by 3 mm		448 447
Cabochon, square girdle; gray and white; two pieces, 21 by 4 mm., which	110.	771
have been ignited at red heat	No.	433
Two disks; red and dull green; 26 by 16 by 2 mm		455
Two rectangular disks; red-brown, mottled; 54 by 36 by 2 and 36 by 31 by		
3 mm		440
Four stones, various cuts and girdles; green		441
Four pendants; gray and brown mottled; average size, 33 by 13 mm	No.	442
Six small rectangular slabs; mottled red, brown, yellow, and gray; 60 by 34,		
58 by 34, and 47 by 33 mm. Gift of George F. Kunz	No.	435
Ten pieces, table and cabochon, elliptical girdles; dull gray with various colored inclusions; 41 by 28 by 3 to 20 by 15 by 2 mm	Νο	439
Thirteen small stones, cabochon, elliptical and rectangular girdles; cloudy	140.	408
gray with dark inclusions; 29 by 21 to 15 by 12 mm. Isaac Lea collection.	No.	434
CHALCEDONY, variety ONYX.		-0-2
LOCALITY NOT RECORDED.		
Compos allination similar white on many harry 60 has 40 many	N7 -	E0=
Cameo, elliptical girdle; white on gray base; 60 by 46 mm		
of George F. Kunz		541
Cameo, elliptical girdle; white on dark brown base; 37 by 28 mm		538
oameo, empacai guule, white on light brown base; 34 by 25 mm	MO.	539

### CHALCEDONY, variety PLASMA.

### INDIA.

Three elliptical buttons; dark blue-green, mottled; average size, 42 by 33 by 7 mm		
24 by 4 mm		
Button, elliptical; gray-green, mottled; 26 by 19 by 6 mm	No.	1472
Disk, cabochon, elliptical girdle; dark green with white streaks; 53 by 40		
by 5 mm	No.	1475
CHALCEDONY, variety PRASE.		
GERMANY.		
Cabochon, elliptical girdle; gray-green; 24.26 carats; 18 by 13 by 11 mm	No.	1431
Saxony.		
Cabochon-brilliant, elliptical girdle; dull green; 9.735 and 9.45 carats; 20 by 13 by 5 and 22 by 12 by 5 mm	No. 3	1430
CHALCEDONY, variety SARDONYX.		
LOCALITY NOT RECORDED.		
Three pieces, elliptical girdles; red-brown, white, and brown, banded; 43 by 29 by 11, 26 by 19 by 8, and 20 by 15 by 7 mm. Colored in Germany. Gift of George F. Kunz		
CHALCEDONY, variety SILICIFIED WOOD.		
UNITED STATES.		
Arizona. Adamana, Apache County:		
Thirty-six stones, cabochon, elliptical and circular girdles; mottled brown, red, yellow, etc.; 52 by 42 by 9 to 16 by 10 by 5 mm. (figs. 4, 5, pl. 7)	No.	824
Chlorastrolite.—See under Prehnite.		

### CHROMITE.

Composition.—Ferrous chromite, FeCr2O4.

Crystallization.—Isometric; habit octahedral; usually massive.

Color.—Black; streak pale brown.

Luster.—Sub-metallic.

Hardness.—5.5; rather soft for use as a precious stone.

Specific gravity.—4.5  $\pm$  0.2.

Optical properties.—Refractive index extremely high; practically opaque.

Methods of identification.—Distinguished from jet by its heaviness; from hematite by its streak.

The mineral occurs in serpentinous rocks, and often accumulates as a "chrome sand" in the beds of streams flowing over such rocks.

It is used rarely for beads and similar objects, being cut mostly only as a matter of scientific interest; value not exceeding the cost of cutting.

#### LIST OF SPECIMENS.

### CANADA (THETFORD).

### CHRYSOBERYL.

Varieties.—Alexandrite; cat's-eye or cymophane.

Composition.—Beryllium aluminate, BeAl, O.

Crystallization.—Orthorhombic; habit tabular.

Color.—Pale yellow, green-yellow, yellow-green, dull green, and rarely brown-yellow or orange-brown; in artificial light, red, especially in the emerald green variety alexandrite; pleochroic, green to red, in deep colored varieties.

Luster.—Vitreous; in cat's-eye, silky.

Hardness.—8.5; a very durable stone.

Specific gravity.— $3.60 \pm 0.1$ .

Optical properties.—Mean refractive index 1.75; double refraction moderate, 0.01; optically biaxial, positive.

The variety cymophane, the true cat's-eye, shows minute laminations which yield a peculiar luster. Alexandrite shows with the microspectroscope a strong absorption band in the yellow and can be recognized by the red color in artificial light; pale colored varieties, including cat's-eye, can be distinguished from similar minerals by the high specific gravity and by optical properties. The mineral occurs in pegmatite and in mica gneiss. The chief commercial sources of chrysoberyl are Brazil and Ceylon. The variety alexandrite comes chiefly from the Takovaya stream in the Ekaterinburg district of Russia, though it has more recently been found in Ceylon. The mineral "was discovered in Russia on the very day on which the coming of age of the Czarevitch Alexander Nicolajevitch, afterwards Czar Alexander II, was celebrated, and in his honour it was named by the Finnish mineralogist Nils von Nordenskiöld."

Stones resembling chrysoberyl have been produced artificially, but their complete identity with the natural mineral remains to be proved. The peculiar property shown by alexandrite of changing color in artificial light renders it rather highly prized as a gem; cat's-eye is usually cut cabochon so as to bring out the luster.

### LIST OF SPECIMENS.

#### BRAZIL.

Brilliant, square girdle; pale yellow-green; 6.329 carats; 11 by 7.5 mm	No. 640
Brilliant, elliptical girdle; green-yellow; 2.5 carats; 10 by 7 by 5 mm	No. 641
Trap-brilliant, elliptical girdle; green-yellow; 1.84 carats; 8 by 7 by 4 mm	No. 642
Table, rectangular girdle; green-yellow; 0.99 carat; 7 by 5 by 3 mm	No. 643
Step-brilliant, elliptical girdle; green-yellow; 0.965 carat; 7.5 by 6 by 3 mm.	No. 644
Table, square girdle; pale green-yellow; 0.745 carat; 5 by 3 mm	No. 645
Step-brilliant; irregular girdle; green-yellow; 0.495 carat; 5 by 3 mm	
Step-brilliant, pentagonal girdle; green-yellow; 0.482 carat; 5 by 5 by 3 mm.	No. 648

Step-brilliant, rectangular girdle; pale yellow; 0.46 carat; 6 by 5 by 2 mm Thirteen small gems, step-brilliant, various girdles; green-yellow; total	No. 646
weight, 2.6 carats	No. 649
Twenty-five small gems, various cuts; green-yellow; total weight, 2.777 carats.  Isaac Lea collection	
CEYLON.	
Brilliant, elliptical girdle; dark yellow-green; 5.1 carats; 10 by 9 by 7 mm Step-brilliant, elliptical girdle (Indian cut); brown-yellow; 4.257 carats; 8	No. <b>634</b>
by 6 by 9 mm	No. 638
Step-brilliant, rectangular girdle; dull yellow-green; 3.9 carats; 12 by 10 by	<b></b>
4 mm. Isaac Lea collection	No. 636
6 mm	No. <b>635</b>
Step-brilliant, elliptical girdle; yellow-green; 1.9 carats; 7 by 6 by 5 mm.	
Isaac Lea collection	No. 637
Brilliant-rose, circular girdle; orange-brown; 1.157 carats; 6.5 by 4 mm	No. 639
CHRYSOBERYL, variety ALEXANDRITE.	
RUSSIA (URAL MOUNTAINS).	
Step-brilliant, rectangular girdle; green; 2.247 carats; 8 by 7 by 4 mm Step. rectangular girdle; green; 1.07 carats; 6.5 by 5.5 by 3.5 mm. Isaac	No. 691
Lea collection.	No. <b>6</b> 88
Trap, rectangular girdle; green; 0.43 carat; 5 by 4 by 3 mm. Isaac Lea	N- enn
collection	140. 030
Lea collection	No. 689

### CHRYSOBERYL, variety CAT'S-EYE.

#### STAM.

Seventeen cat's-eyes and 16 diamond chips mounted in a heavy gold ring.... No. 692

### CHRYSOLITE.

Synonyms.—Olivine, peridot.

Composition.—Magnesium orthosilicate, Mg2SiO4.

Crystallization.—Orthorhombic.

Color.—Yellow-green, green-yellow, or rarely pure yellow; essential, due to ferrous iron replacing magnesium; very faintly pleochroic.

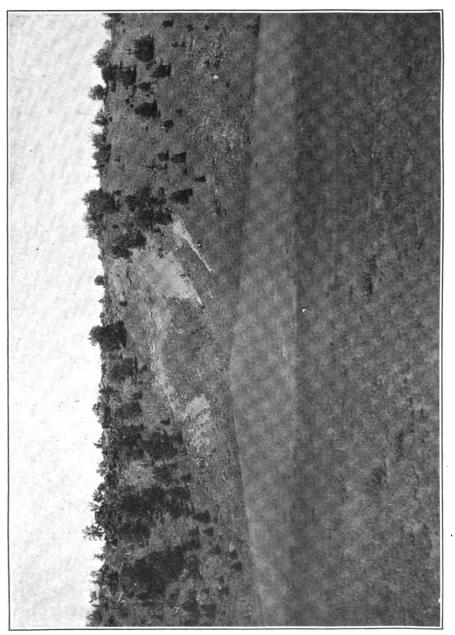
Luster.—Vitreous.

Hardness.—6.5; a fairly durable precious stone.

Specific gravity.—3.40  $\pm$  0.2.

Optical properties.—Mean refractive index, 1.68; double refraction strong, 0.03; optically biaxial, positive.

Chrysolite, also known under the names olivine and peridot, is an abundant constituent of many igneous rocks, as the basalts, peridotites, and stony meteorites, but in most cases in the form of small granules only. When these rocks become disintegrated, the mineral, which is very refractory to weathering agencies, is set free and accumulates in the residual sand. The principal American sources are the Navajo Indian country of Arizona, and New Mexico. (See pl. 5.)



#### LIST OF SPECIMENS.

#### CEYLON.

Step-brilliant, rectangular girdle; yellow-brown; 8.48 carats; 14 by 9 by 8 mm. Isaac Lea collection	No.	555
Step-brilliant, elliptical girdle; pale yellow; 0.43 carat; 5.5 by 5 by 3 mm.  Isaac Lea collection		556
THE LEVANT.		
Step, rectangular girdle; dark green; 18.5 carats; 20 by 16 by 7 mm  Step, rectangular girdle; yellow-green; 8.858 carats; 15 by 12 by 6 mm		
United States.		
Arisona.		
Navajo Indian Reservation:  Brilliant, circular girdle; deep green; 3.93 carats; 10 by 7 mm  Brilliant, square girdle; dark green; 2.74 carats; 9 by 6 mm. Isaac Lea		1181
collection	No.	557
New Mexico.		
Fort Wingate, Bernalillo County:		
Brilliant, circular girdle; dark green; 1.65 carats; 8 by 6 mm	No.	558
Brilliant, circular girdle; dark green; 1.56 carats; 7.5 by 5.5 mm	No.	560
Brilliant, circular girdle; dark green; 1.48 carats; 8 by 5 mm	No.	559
Brilliant, circular girdle; dark green; 1.417 carats; 8 by 5 mm	No.	562
Brilliant, circular girdle; dark green; 1.226 carats; 7.5 by 5 mm	No.	561
Step-brilliant, rectangular girdle; green; 1.094 carats; 7 by 6 by 4 mm.	No.	563
Chrysoprase.—See under Chalcedony.		
Conch Shell.—See under Calcite and Aragonite.		

### CORAL.

Corals are composed of calcium carbonate and are formed as stony secretions within the body of the coral polyp. Of the many varieties known only those formed by the *Corallium rubrum* from the African coast of the Mediterranean are utilized for gem purposes. The material is dredged from a depth of 500 to 800 feet by means of metal dragnets. The colors vary from deep red through pink to greenish, brown, yellow, white, and black. The white, pink, and red varieties are utilized chiefly in the form of necklaces and bracelets.

### LIST OF SPECIMENS.

Bracelet, red
Small chain of beads, red
Two roses, red
Twenty-two spherical beads, white, 3 circular beads, pink; 4 rings, 5 leaf
shaped, and 36 small branching pieces, red. Gift of H. P. Petersen.
Nos. 1843, 1844, 1845

### CORUNDUM.

Varieties and synonyms.—Ruby, sapphire, oriental amethyst, oriental emerald, and oriental topaz.

Composition.—Aluminum sesquioxide, Al₂O₃; the aluminum may be partially replaced by chromium, iron, titanium, etc., yielding colored varieties.

4555--22---4

Crystallization.—Hexagonal-trigonal, rhombohedral; habit usually pyramidal, with rounded edges, and with prominent basal plane (See fig. 4.)

Color.—Colorless when pure; often showing more or less intense coloration, and named accordingly; ruby, the red variety colored by chromium; sapphire, blue, titanium; oriental amethyst, violet, chromium and titanium; oriental emerald, green, iron and titanium; and oriental topaz, yellow, iron. May also show silvery internal reflections, usually in the form of a six-rayed star, owing to symmet-



Fig. 4.-Corundum crystals.

rically arranged inclusions (asteria); pleochroic from pale to deep tints.

Luster.—Rather dull and greasy in natural state; adamantine when cut; transparent to translucent.

Hardness.—9; will scratch every mineral except diamond; extremely durable.

Specific gravity.—4±0.1; noticeably heavy.

Optical properties.—Mean refractive index, 1.76; double refraction weak, 0.008; uniaxial, negative.

The transparent corundums rank among the most valuable of gem stones, and include two recognized varieties, the red ruby and the blue sapphire. The ruby varies in hue from a rose to a deep carmine, the

same crystal occasionally exhibiting different colors, the most approved tint being a "pigeon's blood" red. The sapphire, in general, includes corundums of any color except the red. Specifically, the name is limited in its use to the blue-colored specimens, the approved tints being royal blue, velvet blue, and cornflower blue. The sapphire occasionally exhibits a different color effect by natural light from that seen by artificial light, and as a rule is less brilliant by the latter.

Corundums of other colors are named according to their hues: Oriental emerald, the green-colored kinds, varying in tint from a lively green, exceeding that of the emerald, to a sea or blue-green. Oriental amethyst, purple or amethystine. Oriental topaz, yellow, rivaling the yellow diamond in brilliancy. Oriental hyacinth is hyacinthine in tint and is rare. Adamantine spar includes the hair-brown varieties.

The six-rayed star seen in many clouded corundums, especially when cut cabochon with the summits cutting the vertical axis of the prism, is due to numerous minute crystals or layers within the stone which reflect the incident light so as to produce the stellar effect. These rays are invariably white, though the specimen may be of any color, and may be best seen by artificial light. This chatoyancy, when marked, gives the asteria, or star stone, also known as the star ruby or star sapphire, as the case may be. Should the gem assume a fibrous texture, the chatoyancy affords the "cat's-eye" ray.

Corundum is associated with crystalline rocks as granular limestone or dolomite, gneiss, granite, mica, and chlorite schist. The finest sapphires are usually obtained from the beds of streams, either in modified hexagonal prisms or in rolled masses, accompanied by grains of magnetic iron ore and other heavy minerals.

The best rubies come from the mines of upper Burma, in an area about 30 miles square, of which Mogok is the center, where they are found in place in crystalline limestone; they occur also in gravel and in the soil of the hillsides. A similar locality exists in the marble hills of Sagyin, 16 miles north of Mandalay. Ruby mines have also been worked at Jagdalik, near Kabul, Afghanistan. Blue sapphires are brought from Ceylon.

The great corundum region of the United States extends from the Virginia line through North and South Carolina, across Georgia and into Alabama. Numerous localities are known in the crystalline rocks of the region, especially in Madison, Buncombe, Haywood, Jackson, Macon, and Clay Counties, North Carolina. Rubies rivaling those from Burma in color have been found in the Cowee district of this State, but the region affords no commercial supply. Fine gem sapphires are found on the river bars in the Upper Missouri near Helena, Montana. They are most abundant at Eldorado Bar, French-

mans Bar, and Yogo Gulch, where they occur in a pyroxenite and as pebbles more or less rolled in the sands resulting from its disintegration. The Montana gems rarely exceed one-fourth to one-half inch in length and range in color from light green, light blue, steel blue, bluish red, light red, and intermediate shades; frequently the colors mentioned will appear red or assume a reddish tinge by artificial light. They are usually dichroic and often blue in one direction and red in another. (See pl. 6.)

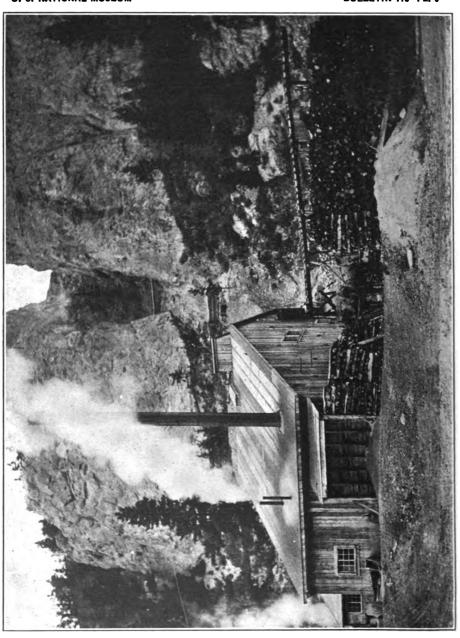
Rubies of a high degree of perfection are now produced artificially and their manufacture has become a matter of trade importance. The artificial stone, in crystallization and composition, is identical with the natural.

### CORUNDUM, variety RUBY.

### CEYLON.

Step-brilliant, heart-shaped girdle; pale violet red; 6.84 carats; 13 by 10 by 7 mm. Isaac Lea collection	No	102
Step brilliant alliptical sindle violet and 4 100 content 11 by 7 by 65 mm	140.	190
Step-brilliant, elliptical girdle; violet red; 4.193 carats; 11 by 7 by 6.5 mm.	NT.	107
Isaac Lea collection	No.	197
Step-brilliant, elliptical girdle; pale red; 3.5 carats; 10 by 7.5 by 6 mm.	37	• •
Isaac Lea collection.	No.	14
Step-brilliant, elliptical girdle; very pale red; 2.754 carats; 9 by 7.5 by 5 mm.		
Isaac Lea collection	No.	16
Step-brilliant, elliptical girdle; violet-red; 1.265 carats; 6.5 by 6 by 5 mm.		
Isaac Lea collection	No.	202
collection	No.	201
Step-brilliant, square girdle; deep red; 0.81 carat; 5 by 4 mm. Isaac Lea		
collection	No.	200
Step-brilliant, rectangular girdle; deep red; 0.81 carat; 6 by 5 by 4 mm.		
Isaac Lea collection	No.	205
Step-brilliant, irregular girdle; deep red; 0.737 carat; 7.5 by 6 by 3 mm.		
Isaac Lea collection	No.	203
Brilliant, elliptical girdle; pale red; 0.70 carat; 6 by 5 by 4 mm. Isaac Lea		
collection	No.	209
Step-brilliant, rectangular girdle; deep red; 0.64 carat; 5.5 by 4.5 by 3 mm.		
Isaac Lea collection	No.	208
Step-brilliant, circular girdle; deep red; 0.627 carat; 5.5 by 3 mm. Isaac		
Les collection	No	206
Step-brilliant, elliptical girdle; deep red; 0.625 carat; 6 by 4.5 by 3 mm.		
Isaac Lea collection	No	207
Step-brilliant, rectangular girdle; pale, cloudy red; 0.44 carat; 5 by 4 by	110.	20.
2.5 mm. Isaac Lea collection	No	69
One lot of 239 small gems of which 228 are cut and 11 uncut. Mostly step-		09
brilliant, various girdles; red; total weight, 18.36 carats		910
Drillant, various girdies, red; west weight, 10.50 carats	140.	213
UNITED STATES.		
Montana.		
Brilliant, circular girdle; red-violet; 2.165 carats; 8 by 3 mm. Isaac Lea		

Brilliant, circular girdle; very pale red; 1.215 carats; 6 by 4 mm. Isaac Lea



Table, rectangular girdle; red violet; 1.025 carats; 6.5 by 5 by 2 mm. Isaac Lea collection  Brilliant, elliptical girdle; red; 0.58 carat; 6 by 5 by 2.5 mm. Isaac Lea collection  Brilliant, circular girdle; red; 0.45 carat; 4 by 3.5 mm. Isaac Lea collection.  Rock Creek, Granite County:  Ten gems, brilliant cut, circular girdle; red and violet-red; total weight, 3.52 carats; 4 by 3 mm. to 3.5 by 2.5 mm.	No. No.	1022 1023
North Carolina.		
Corundum Hill, Macon County:  Step-brilliant, rectangular girdle; red; 1.528 carats; 9 by 5 by 4 mm  Step-brilliant, square girdle; red; 0.89 carat; 6 by 4 mm  Step-brilliant, square girdle; red; 0.357 carat; 4 by 2.5 mm	No.	195
LOCALITY NOT RECORDED.		
Brilliant, square girdle; deep red; 1 carat; 5.5 by 5.5 by 4 mm. Mounted in a ring. Isaac Lea collection	No.	218
CORUNDUM, variety RUBY (ASTERIA).		
CEYLON.		
Cabochon, circular girdle; red, mottled; 9.33 carats; 11 by 9 mm. Isaac Lea		
collection		
Cabochon, circular girdle (irregular); 2.365 carats; 6 by 6 mm. Isaac Lea collection		213
Cabochon, circular girdle; red; 1.56 carats; 6.5 by 4 mm. Isaac Lea collection	No	212
Cabochon, circular girdle; cloudy red; 1.364 carats; 6 by 5 mm. Isaac Lea collection		
Cabochon, elliptical girdle; very cloudy red; 1.3 carats; 7 by 6 by 4 mm.  Isaac Lea collection	Nο	211
Cabochon, elliptical girdle; red; 1.284 carats; 7 by 6 by 4 mm. Isaac Lea collection		204
Cabochon, circular girdle; cloudy red; 1.157 carats; 6 by 5 mm. Isaac Lea collection	No.	215
LOCALITY NOT RECORDED.		
Cabochon, circular girdle; red; 1.569 carats; 7 by 4 mm		
CORUNDUM, variety SAPPHIRE.		
AUSTRALIA.		
Queensland.		
Step-brillant, elliptical girdle; deep green-blue; 2.34 carats; 8 by 7 by 5 mm. Isaac Lea collection	No.	1823

### CEYLON.

Step-brilliant, elliptical girdle; blue; 31.38 carats; 20 by 13 by 12 mm.  The Shepard collection	No.	1027
The Shepard collection		,
Step-brilliant, rectangular girdle; blue-gray; 21.53 carate; 17 by 13.5 by		•
10 mm. Issac Les collection	No.	€
Step-brilliant, rectangular girdle; pale blue; 11.33 carats; 12 by 13 by 8.5 mm. Isaac Lea collection	No	•
Step-brilliant, elliptical girdle; pale blue; 10.78 carate; 14 by 10 by 9 mm.		•
Isaac Lea collection	No.	E
Step-brilliant, rectangular girdle; pale blue; 6.936 carats; 12 by 11 by 6		
mm. Isaac Les collection	No.	10
Step-brilliant, elliptical girdle; deep blue; 6.595 carats; 14 by 10 by 4.5 mm. Isaac Lea collection	N.	_
Step-brilliant, circular girdle; violet-blue; 5.488 carats; 10 by 7 mm. Isaac	140.	7
Les collection	No.	8
Lea collection		
Isaac Lea collection	No.	19
Step-brilliant, oval girdle; pale blue; 4.526 carats; 10.5 by 8 by 6 mm.		
Isaac Lea collection	No.	24
Step-brilliant, square girdle; deep blue; 4.057 carats; 10 by 5 mm. Isaac		
Lea collection	No.	15
Step-brilliant, elliptical girdle (irregular); pale blue; 3.865 carats; 9 by 8	••	
by 7 mm. Bequest, William H. Forwood	No.	1028
Step-brilliant, elliptical girdle; pale green-blue; 3.27 carats; 10 by 8 by 5 mm. Isaac Lea collection	N _o	22
Step-brilliant, oval girdle; blue; 2.96 carats; 8 by 7 by 6 mm. Isaac Lea	140.	22
	No.	20
collection		_
collection	No.	32
Step-brilliant, oval girdle; pale blue; 2.815 carats; 9 by 8 by 5 mm. Isaac		
Les collection	No.	19
Step-brilliant, rectangular girdle; very pale blue; 2.645 carats; 10 by 8 by		
4.5 mm. Isaac Lea collection	No.	17
Step-brilliant, rectangular girdle; gray-blue; 2.44 carats; 7.25 by 6.5 by 6	•	_
mm. Issac Lea collection	No.	34
Step-brilliant, elliptical girdle; blue; 2.155 carats; 9 by 7 by 4 mm. Isaac Lea collection	N.	23
Step-brilliant, circular girdle; blue; 2.014 carats; 7 by 6 mm. Isaac Lea	110.	20
collection	No.	28
collection		
collection		37
Step-brilliant, square girdle; violet-blue; 1.62 carats; 6 by 5 mm. Isaac		
Lea collection	No.	57
Step-brilliant, elliptical girdle; blue; 1.614 carats; 8 by 6 by 3.5 mm. Isaac		
Lea collection	No.	47
Step-brilliant, elliptical girdle; pale violet-blue; 1.577 carats; 8 by 5 by 5 mm. Isaac Lea collection	NT.	40
mm. Isaac Lea collection	140.	49
collection	No	64
Step-brilliant, elliptical girdle; blue-gray; 1.49 carats; 6 by 5 by 6 mm.	-10.	<b>U</b> 2
Isaac Lea collection	No.	40
Step-brilliant, irregular oval girdle; colorless with blue streaks; 1.445		
carats; 6 by 6 by 5 mm. Isaac Lea collection	No.	75

Step-brilliant, circular girdle; light blue; 1.42 carats; 7 by 4 mm. Isaac Lea collection	N ₀	60
Step-brilliant, irregular girdle; colorless, blotched with blue; 1.355 carats;	110.	•
7 by 6 by 4 mm. Issac Les collection	NT.	m 4
Step-brilliant, square girdle; light blue; 1.35 carats; 7 by 6.5 by 4 mm.	140.	74
Step-orimant, square girdle; ngnt blue; 1.55 carats; 7 by 6.5 by 4 mm.	<b>3</b> 7 .	
Isaac Lea collection	NO.	44
Step-brilliant, irregular elliptical girdle; pale blue; 1.296 carats; 7 by 5 by		
5 mm. Isaac Lea collection	No.	78
Step-brilliant, elliptical girdle; colorless with blue streaks; 1.279 carats;		
6.5 by 5 by 5 mm. Isaac Lea collection	No.	77
Step-brilliant, square girdle; blue; 1.25 carats; 6 by 4 mm. Isaac Lea collection	No	66
Step-brilliant, elliptical girdle; colorless with blue blotches; 1.22 carats;		•
7 by 5.5 by 4 mm. Isaac Lea collection	Nο	63
Step-brilliant, circular girdle; very pale blue; 1.192 carate; 7 by 4 mm.	110.	00
	M.	52
Isaac Lea collection	140.	02
Step-brilliant, circular girdle; very pale blue; 1.157 carats; 6.5 by 4 mm.	3.7	
Isaac Lea collection	No.	56
Step-brilliant, rectangular girdle; pale blue; 1.15 carats; 6 by 4.5 by 5 mm.		
Isaac Lea collection	No.	72
Step-brilliant, square girdle; pale blue; 1.105 carats; 6 by 4 mm. Isaac		
Les collection	No.	79
Step-brilliant, elliptical girdle; pale blue; 1.043 carats; 7 by 5 by 4 mm.		
Isaac Lea collection	No.	84
Step-brilliant, elliptical girdle; deep blue; 1 carat; 7 by 6 by 3.5 mm.		
Isaac Lea collection	No.	61
Step-brilliant, elliptical girdle; deep blue; 0.98 carat; 6 by 5 by 4 mm.		
Isaac Lea collection	No.	45
Step-brilliant, elliptical girdle (irregular); blue; 0.977 carat; 6.5 by 5 by 4		
mm. Isaac Lea collection	No.	90
Step-brilliant, rectangular girdle; deep blue; 0.962 carat; 6 by 5 by 4 mm.		•
Isaac Lea collection	Nο	68
Step-brilliant, elliptical girdle; colorless, with blue blotches; 0.957 carat;	110.	•
6 by 4.5 by 5 mm. Isaac Lea collection	Ma	82
	140.	04
Step-brilliant, elliptical girdle; colorless, with blue streaks; 0.957 carat;	<b>N</b> T -	0=
6 by 4.5 by 5 mm. Isaac Lea collection		87
Step-brilliant, oval girdle; deep violet blue; 0.922 carat; 6.5 by 5 by 3.5 mm.		
Isaac Lea collection	No.	71
Step-brilliant, elliptical girdle; blue; 0.892 carat; 6 by 5 by 4 mm. Isaac		
Lea collection		102
Step-brilliant, elliptical girdle; colorless, with blue streaks; 0.887 carat;		
6.5 by 5 by 3.5 mm. Isaac Lea collection	No.	85
Step-brilliant, elliptical girdle; deep blue; 0.887 carat; 6.5 by 5 by 3 mm.		
Tagge Les collection	No.	88
Step-brilliant, elliptical girdle; colorless, with slight blue streaks; 0.855		
carat; 6.5 by 5 by 3.5 mm. Isaac Les collection	No.	73
Step-brilliant, circular girdle; colorless, blotched with blue; 0.85 carat; 5		
by 5 mm. Isaac Lea collection		101
Step-brilliant, irregular oval girdle; deep blue; 0.811 carat; 6.5 by 5 by 3		
mm. Isaac Lea collection		92
Step-brilliant, rectangular girdle; light blue; 0.79 carat; 6 by 4 by 3.5 mm.		02
		. 81
· · · · · · · · · · · · · · · · · · ·		. 01
Step-brilliant, elliptical girdle; blue; 0.77 carat; 5.5 by 5 by 4 mm. Isaac	N.	100

Step-brilliant, elliptical girdle; colorless, with blue blotches; 0.749 carat;		
6 by 5 by 3.5 mm. Isaac Lea collection	No.	99
Step-brilliant, rectangular girdle; green-blue; 0.733 carat; 6 by 5 by 3.5 mm	No	133
Step-brilliant, irregular oval girdle; violet-blue; 0.73 carat; 6 by 5 by 4 mm.		-00
Isaac Lea collection		105
Step-brilliant, circular girdle; light blue; 0.735 carat; 5 by 4 mm. Isaac		
Lea collection	No.	97
Step-brilliant, elliptical girdle; pale blue; 0.72 carat; 6 by 5 by 4 mm.		
Isaac Lea collection	No.	95
Isaac Lea collection		
Isaac Lea collection	No.	106
Step-brilliant, oval girdle; violet-blue; 0.715 carat; 5.5 by 4 by 4 mm.		
Isaac Lea collection	No.	51
Step-brilliant, elliptical girdle; pale violet-blue; 0.7 carat; 6 by 4 by 4.5		
mm. Isaac Lea collection	No.	108
Step-brilliant, elliptical girdle; smoky blue; 0.68 carat; 5.7 by 5 by 3 mm.		
Isaac Lea collection	No.	86
Step-brilliant, elliptical girdle; deep blue; 0.68 carat; 6 by 4.5 by 3.25 mm.		
Isaac Lea collection	No.	91
Step-brilliant, elliptical-girdle; deep blue; 0.66 carat; 4.5 by 3 by 4.5 mm.		
Isaac Lea collection	No.	124
Isaac Lea collection		
mm. Isaac Lea collection	No.	123
Step-brilliant, rectangular girdle; pale blue; 0.64 carat; 6 by 5 by 3 mm.		
Isaac Lea collection	No.	93
Step-brilliant, elliptical girdle; blue; 0.588 carat; 5 by 4.5 by 3 mm. Isaac		
Lea collection	No.	12
Lea collection		
Isaac Lea collection	No.	103
Step-brilliant, irregular oval girdle; deep blue; 0.569 carat; 5.5 by 5 by 3		
mm. Isaac Lea collection	No.	107
Step-brilliant, elliptical girdle; deep blue; 0.565 carat; 5 by 4.5 by 3.5 mm.		
Isaac Lea collection	No.	110
Isaac Lea collection		
Isaac Lea collection		125
Step-brilliant, rectangular girdle; smoky blue; 0.557 carat; 5.5 by 4 by 3		
mm. Isaac Lea collection	No.	104
Step-brilliant, circular girdle; colorless, with blue at girdle; 0.555 carat;		
5 by 3 mm. Isaac Lea collection	No.	126
Step-brilliant, elliptical girdle; colorless, with blue blotches; 0.505 carat;		
4.5 by 4 by 3 mm. Isaac Lea collection	No.	116
Step-brilliant, elliptical girdle; pale blue; 0.48 carat; 5 by 3.5 by 3 mm.		
Isaac Lea collection	No.	115
Step-brilliant, oval girdle; almost colorless, blue at girdle; 0.475 carat;		
4.5 by 4 by 5 mm. Issue Les conection	No.	119
Step-brilliant, ellipitical girdle; deep blue; 0.46 carat; 4.5 by 3.5 by 3 mm.		
Isaac Lea collection	No.	127
Step-brilliant, circular girdle; pale blue; 0.39 carat; 4 by 3 mm. Isaac	•	
Lea collection	No.	121
Step-brilliant, elliptical girdle; almost colorless, blue at girdle; 0.38 carat;	NT	110
4.5 by 3.5 by 2.5 mm. Issac Lea collection	No.	118
Step-brilliant, circular girdle; almost colorless, blue at girdle; 0.36 carat;	No	190

ORIGINATION OF CHIEF AND IMMOROUS STORES.		U
Step-brilliant, oval girdle; blue; 0.355 carat; 4 by 3.5 by 2.5 mm. Isaac Lea collection	No.	122
Step-brilliant, elliptical girdle; pale blue; 0.34 carat; 4.5 by 3.5 by 2 mm.  Isaac Lea collection		128
Step-brilliant, irregular oval girdle; deep blue; 0.33 carat; 4 by 2.5 by 2 mm.  Isaac Lea collection		114
Step-brilliant, circular girdle; deep blue; 0.325 carat; 3.5 by 3 mm. Isaac Lea collection	No.	117
Step-brilliant, various girdles; mostly blue; 18 gems, total weight, 5.135 carats; average, 3 by 3 by 2 mm		
SIBERIA (URAL MOUNTAINS).		
Step-brilliant, elliptical girdle; deep blue; 1.189 carats; 7 by 6 by 4 mm	No.	170
UNITED STATES.		
Montana.		
Brilliant, circular girdle; very pale blue; 3.15 carats; 8 by 5 mm. Isaac Lea collection	No. I	1011
Brilliant, circular girdle; very pale blue; 1.73 carats; 7.5 by 2.5 mm. Isaac Lea collection	No. I	1012
Brilliant, circular girdle; pale blue; 1.40 carats; 6 by 4 mm. Isaac Lea collection	Ma 1	1010
Brilliant, circular girdle; blue; 1.31 carats; 6 by 4 mm. Isaac Lea collec-		
brilliant, square girdle; blue; 1.156 carats; 6 by 5 mm	No.	158
brilliant, circular girdle; blue; 0.78 carat; 5 by 3 mm. Isaac Lea collec-		
tionBrilliant, circular girdle; blue; 0.535 carat; 4.5 by 3 mm. Isaac Lea collec-		
tion  Brilliant, rectangular girdle; pale blue; 0.36 carat; 4 by 3 by 2.5 mm.  Isaac Lea collection		
Rock Creek, Granite County:  Brilliant, circular girdle; three gems, one green-blue, two very pale		.0.20
blue; total weight, 1.265 carats; 4 by 3 mm	No. 1	024
Step-brilliant, elliptical girdle; deep blue; two gems, 1.86 and 1.8 carats; 8 by 7 by 5 mm. Isaac Lea collection	No.	<b>4</b> 58
North Carolina.		
Corundum Hill, Macon County: Step-brilliant, rectangular girdle; dark green-blue; 3.865 carats; 11 by	•	
8 by 6 mm		
of Clarence S. Bement		
by 4 by 4 mm	140.	100
CORUNDUM, variety SAPPHIRE (ASTERIA).  CEYLON.		
Polished pebble; blue gray; 100.11 carats; 34 by 27 by 14 mm. Isaac Lea		
collection	No.	30
Cabochon, circular girdle; blue; 68.77 carats; 24 by 14 mm. Isaac Lea collection	No.	172

Cabochon, circular girdle; gray (banded); 50.5 carats; 25 by 10 mm. Isaac		
Les collection	No.	171
Cabochon, circular girdle; violet; 50.349 carats; 22 by 13 mm. Isaac Lea collection	No.	173
collection		
Lea collection	No.	174
Cabochon, circular girdle; gray blue; 28.3 carats; 18 by 10 mm. Isaac		
Les collection	No.	175
Cabochon, circular girdle; pale gray; 15.3 carats; 14 by 10 mm. Isaac Lee		
collection	No.	176
Cabochon, circular girdle; milky white; 10.2 carats; 11 by 9.5 mm	No.	185
Cabochon, circular girdle; gray-blue; 7.525 carats; 11 by 8 mm. Isaac		
	No.	179
Cabochon, circular girdle; milky white; 6.388 carats; 11 by 6.5 mm. Isaac Lea collection	No	178
Cabochon, elliptical girdle; light blue; 5.486 carats; 11 by 9 by 6 mm.	110.	110
Isaac Les collection	No	180
Cabochon, circular girdle; light violet; 4.98 carats; 10 by 7 mm		186
Cabochon, irregular girdle (polished pebble); very pale blue-violet; 4.86	110.	100
carats; 9 by 9 by 6 mm. Isaac Lea collection	Ma	188
Cabochon, circular girdle; blue-gray; 4.48 carats; 9 by 7 mm		187
Cabochon, circular girdle; dark blue; 4.095 carats; 9 by 6 mm. Isaac Lea	140.	101
collection	No.	181
Cabochon, circular girdle; milky white; 3.019 carats; 9 by 5 mm. Issac		
Lea collection	No.	183
Cabochon, circular girdle; pale blue-gray; 2.336 carats; 8 by 5 mm. Isaac Lea collection	No	177
Cabochon, circular girdle; gray; 2.3 carats; 8 by 7 by 7 mm. Isaac Lea col-	110.	177
	No	182
lection	No.	190
Cabochon, circular girdle; blue-gray; 1.66 carats; 6 by 6 mm. Isaac Lea col-		
lection	No.	184
Cabochon, irregular girdle; gray; 1 carat; 5 by 5 by 3 mm. Isaac Lea col-	<b>3</b> T.	100
lection	No.	199
UNITED STATES.		
North Carolina.		
Ellijay, Macon County:		
Cabochon, circular girdle; bronze; 10.689 carats; 14 by 7 mm	No.	191
Cabochon, circular girdle; bronze; 4.67 carats; 10 by 5.5 mm		192
Cabochon, elliptical girdle; bronze; 3.439 carats; 11 by 8 by 4 mm		193
CORUNDUM, variety WHITE SAPPHIRE.		
CEYLON.		
Cabochon, elliptical girdle; cloudy white; 3.57 carats; 12.5 by 7 by 5 mm.		
	No.	25
Step-brilliant, square girdle; colorless; 0.85 carat; 6 by 3 mm. Isaac Lea	••	
collection	No.	65
Step-brilliant, rectangular girdle; colorless; 0.775 carat; 6 by 5 by 3.5 mm.	<b>N</b> T.	~~
Isaac Lea collection.	No.	83
Step-brilliant, elliptical girdle; colorless; 0.707 carat; 6 by 5 by 4 mm.	NT.	04

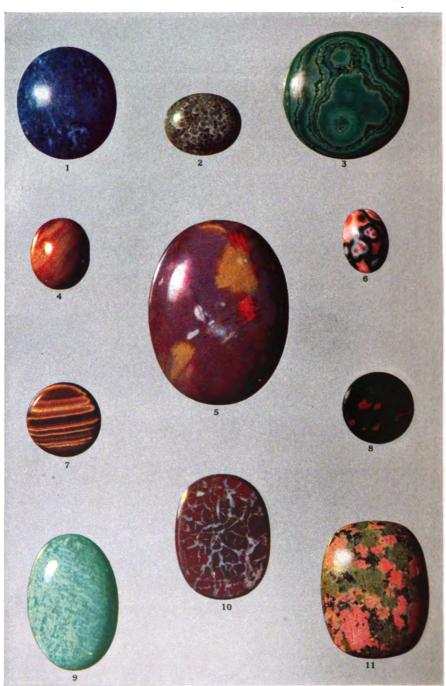
Step-brilliant, elliptical girdle; colorless; 0.228 carat; 5 by 4 by 2 mm.  Isaac Lea collection		113
CORUNDUM, variety ORIENTAL AMETHYST.		
·		
CEYLON.		
Step-brilliant, elliptical girdle (Indian cut); blue-violet; 13.214 carats; 13 by 8 by 13 mm. Isaac Lea collection	No.	11
Isaac Lea collection.  Step-brilliant, circular girdle; violet; 2.4 carats; 8 by 5.5 mm. Isaac Lea	No.	27
collection	No.	21
collection		26
Isaac Lea collection	No.	58
Step-brilliant, rectangular girdle; violet; 1.44 carats; 8.5 by 6 by 4 mm Step-brilliant, elliptical girdle; violet; 1.4 carats; 8 by 6 by 4 mm. Isaac	No.	130
Lea collection		41
Isaac Lea collection		55
Lea collection	No.	80
Isaac Lea collection		70
2 mm. Isaac Lea collection		53 135
S. Bement		129
CORUNDUM, variety ORIENTAL EMERALD.		
•		
CEYLON.		
Step-brilliant, rectangular girdle; pale blue-green; 4.265 carats; 13 by 10 by		
6 mm. Isaac Lea collection		9
Step-brilliant, circular girdle; deep blue-green; 0.863 carat; 7 by 3.5 mm Step-brilliant, elliptical girdle; deep blue-green; 0.657 carat; 6 by 5 by 3.5		131
mm	No.	132
Step-brilliant, square girdle; pale green; 0.4 carat; 4 by 3 mm. Isaac Lea collection	No.	112
UNITED STATES.		
Montana.		
Step-brilliant, rectangular girdle; pale green; 2.499 carats; 9 by 6 by 5 mm	No	156
Step-brilliant, square girdle; blue-green; 0.813 carat; 5.5 by 4 mm. Gift of Clarence S. Bement		157
Brilliant, circular girdle; blue-green; 0.7 carat; 5 by 4 mm	No.	
North Carolina.		
Corundum Hill, Macon County:		
Step-brilliant, rectangular girdle; blue-green; 1.015 carats; 6.5 by 5 by	37.	105
4 mm	110.	TQ9

### CORUNDUM, variety ORIENTAL TOPAZ.

### AUSTRALIA.

### Queensland.

Lea collection	No.	1824
CEYLON.		
Step-brilliant, rectangular girdle; pale yellow; 7.6 carats; 12 by 10 by 7		
mm. Isaac Lea collection.	No.	2
Step-brilliant, elliptical girdle; pale orange-yellow; 3.307 carats; 9.5 by 7.5 by 5 mm. Isaac Lea collection	No	18
Step-brilliant, rectangular girdle; pale yellow; 3.277 carats; 10 by 7 by 6	NO.	10
mm. Isaac Lea collection	No.	33
Step-brilliant, elliptical girdle; pale yellow; 3.052 carats; 10 by 7 by 5 mm.		
Isaac Lea collection.	No.	31
Step-brilliant, elliptical girdle; pale yellow; 2.369 carats; 9 by 7.5 by 4.5 mm. Isaac Lea collection.	No	35
Step-brilliant, elliptical girdle; pale green-yellow; 2.336 carats; 9 by 8 by	110.	30
5 mm. Isaac Lea collection.	No.	29
Step-brilliant, irregular girdle; very pale yellow; 1.982 carats; 7.5 by 7 by		
4.5 mm. Isaac Lea collection	No.	43
Step-brilliant, elliptical girdle; very pale yellow; 1.923 carats; 8 by 7 by	27	~~
5 mm. Isaac Lea collection	No.	38
mm. Isaac Lea collection	No	46
Step-brilliant, elliptical girdle; deep yellow; 1.518 carats; 8 by 4 by 6 mm.	-10.	10
Isaac Lea collection	No.	42
Step-brilliant, elliptical girdle; pale yellow; 1.46 carats; 7 by 5.5 by 4.5		
mm. Isaac Lea collection.	No.	39
Step-brilliant, elliptical girdle; very pale yellow; 1.37 carats; 7 by 6 by 4	<b>N</b> .	
mm. Isaac Lea collection	No.	50
mm. Isaac Lea collection	No	48
Step-brilliant, elliptical girdle; very deep yellow; 1.27 carats; 7 by 6 by 4		
mm. Isaac Lea collection	No.	54
Step-brilliant, elliptical girdle; very pale yellow; 1.18 carats; 6 by 5 by 5		
mm. Isaac Lea collection	No.	76
Step-brilliant, elliptical girdle; very pale yellow; 1.105 carats; 6.5 by 5 by	N.	
4.5 mm. Isaac Lea collection	NO.	59
Isaac Lea collection	No	67
Step-brilliant, elliptical girdle; very pale yellow; 0.917 carat; 6 by 5 by 4		٠.
mm. Isaac Lea collection	No.	62
Brilliant, square girdle; green-yellow; 0.889 carat; 6 by 4 mm. Gift of		
Clarence S. Bement.	No.	134
Step-brilliant, elliptical girdle; pale yellow; 0.776 carat; 6 by 5 by 3 mm.	<b>&gt;</b> 7	
Isaac Lea collection	NO.	89
Isaac Lea collection	No	36
Step-brilliant, elliptical girdle; pale yellow; 0.742 carat; 6 by 5 by 3 mm.		-
Isaac Lea collection	No.	98
Step-brilliant, rectangular girdle; very pale yellow; 0.659 carat; 5.5 by 4.5		
by 3.5 mm. Isaac Lea collection	No.	96



SEMI-PRECIOUS STONES
FOR DESCRIPTION OF PLATE SEE PAGE VIII

Step-brilliant, elliptical girdle; pale orange-yellow; 0.646 carat; 6 by 4.5 by 3 mm. Isaac Lea collection
UNITED STATES.
Montana.
Brilliant, circular girdle; yellow; 1.34 carats; 6 by 4 mm. Isaac Lea col-
lection
Isaac Lea collection
Brilliant, rectangular girdle; pale yellow; 0.76 carat; 6 by 4 by 3.5 mm.
Isaac Lea collection
Brilliant, circular girdle; pale yellow; 0.64 carat; 5 by 3 mm. Isaac Lea
collection
Step-brilliant, circular girdle; deep yellow; 0.5 carat; 4.5 by 3 mm. Isaac Lea collection
Brilliant, circular girdle; deep yellow; 0.5 carat; 4.5 by 3 mm. Isaac Lea
collection
Isaac Lea collection
Brilliant, circular girdle; pale yellow; 0.405 carat; 4 by 2.5 mm. Isaac
Lea collection
Rock Creek, Granite County:
Brilliant, circular girdle; 4 gems deep yellow, one pale yellow; total weight 1.8 carats; average size, 4 by 3 mm
North Carolina.
Corundum Hill, Macon County:  Step-brilliant, rectangular girdle; pale yellow; 1.92 carats; 9 by 7 by 5  mm
CROCIDOLITE.
Crocidolite, also known as "Tiger Eye," is a fibrous, asbestiform mineral which in many cases, through the oxidation of the iron and an infiltration of silica, has become altered into a hard, compact siliceous stone, with often a beautiful chatoyant play of colors, and is much used in cheaper forms of jewelry. The source is South Africa.

### LIST OF SPECIMENS.

### UNION OF SOUTH AFRICA (GRIQUALAND WEST).

Necklace of 56 round beads; brown; 7 to 4 mm. diameter. Bequest, William H. Forwood	o. 1547
Cabochon, elliptical girdle; light brown and white; 64.5 carats; 44 by 33 by 5	
mm. Gift of George F. Kunz No	o. 1 <b>453</b>
Cabochon, circular girdle; brown; two gems, 17.57 and 17.37 carats; 17 by 8,	
20 by 5 mm. (fig. 7, pl. 7)	o. 1455
Cabochon, elliptical girdle; brown; two gems, 14.86 and 14.42 carats; 24 by	
17 by 5 mm. Isaac Lea collection	o. 1454
Cabochon, circular girdle; green; 12.5 carats; 17 by 6 mm	o. 1456

Cabochon, circular girdle; brown; 5.74 carats; 11 by 7 mm	No. 1457
Cameo; elliptical girdle; brown; 5.025 carats; 14 by 10 by 5 mm	No. 1458
Cabochon, elliptical girdle; brown; 2.025 carats; 12 by 6 by 4 mm	No. 1452
Cabochon, elliptical girdle; two gems, one brown, one green; 1.49 and 1.42	
carats; 9 by 6 by 4, 10 by 5 by 4 mm	No. 1458

Demantoid.—See under Garnet.

### DIAMOND.

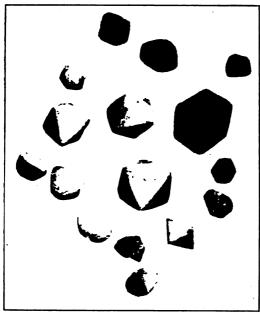


Fig. 5.—Diamond crystals. Showing characteristic forms. (Enlarged 6 diameters.)

From Gardner F. Williams collection.

Composition.—Carbon (isometric form), C.

Evystallization.—Isometric, holohedral; habit usually octahedral, with rounded edges; cleavage, octahedral (fig. 5).

Color.—Colorless when pure; often showing nonessential violet, blue, green, yellow, brown, or red colors, owing to the presence of traces of impurities of unknown nature.

Luster.—Rather dull and greasy in the natural state, brilliantly adamantine when cut; when free from flaws, transparent.

Hardness.—10; will

scratch every other known mineral; the most durable of precious stones.

Specific gravity.— $3.52 \pm 0.02$  noticeably heavy.

Optical properties.—Refractive index, 2.42; isotropic in polarized light, or slightly anisotropic if under strain; dispersion of spectrum colors very high.

Miscellaneous properties.—A rather good conductor of heat so that it feels cold when placed against the skin (in a sensitive spot).

Occurrence.—Occurs in ultra-basic igneous rocks and in gravels derived by their disintegration. (See Williams collection of rocks from the diamond mines of South Africa, p. 135.)

Artificial production.—Made by Moissan by the sudden chilling of molten iron containing dissolved carbon; has also been made by other processes involving simultaneous action of high temperature and pressure.

The diamond is the hardest of gems; is the only one that is combustible; is the most highly refractive; and surpasses all others in the property of dispersing light—that is, dividing light into colored rays, causing that peculiar flash of prismatic hues called its fire. The cleavage of the diamond is highly perfect and parallel to the octahedral faces. The luster, especially of artificial faces, is peculiarly brilliant and is superior to that of any other gem. The remarkable brilliancy of the diamond results in part from the total reflection of light from its internal faces when the incident ray strikes it at an angle of a little more than 24 degrees. The stone also refracts light strongly. To the refractive and dispersive power of the diamond is due the flash of colors or fire, characteristic of the stone, the colorless specimens exhibiting it to the greatest degree; the colored to the least, or not at all.

The range of color of the diamond is extensive, including nearly all the prismatic hues. The whites, yellows, and browns perhaps afford the greatest number of shades and are the most numerous. Next to these, for colored specimens, the greens, including all shades, are most plentiful; the pure grass-green and emerald-colored stones are, however, very rare, as, indeed, are all the strongly colored specimens. Red stones of strong, rich, deep tints are extremely rare; so, too, are the garnet, hyacinth, rose-red, peach-blossom, and lilac-colored specimens. Practically all of the blue stones known have been found in India, and their occurrence is as rare as the red. Cinnamon, brown, black, milky, and opalescent stones are occasionally met with. Pure colorless diamonds without a flaw or tint of any kind are more rare than is generally supposed.

In diamonds, perfectly white stones or decided tints of red, rose green, or blue are most highly prized. Fine cinnamon, salmon, brown, black, or yellow stones are also much esteemed. When flawless and without tint of any kind they are termed "first water." If they possess a steely-blue color they are called "blue white." It is impossible to estimate the value of a diamond by its weight. Color, brilliancy, cut, and general perfection of the stone are all to be considered. Of two stones, both flawless and of equal weight, one may be worth twice the other. Off-colored or defective stones may sell at carat prices regardless of size, while the value of an ordinary good water stone increases in an increasing ratio with its weight up to about 20 carats, beyond which no rule holds good. Exceptionally perfect stones have no fixed value, the price depending upon the purity and brilliancy and, of course, the condition of the market.

Among the historically interesting diamonds are the "Regent" or "Pitt" diamond, weighing 136½ carats, for many years the finest large diamond in the world. It was discovered in India in 1701, and weighed 410 carats in the rough. The finest blue diamond is the

4555-22---5

"Hope," an almost sapphire-blue stone, weighing 441 carats. The "Dresden Green" is the finest green diamond, a pear-shaped 481carat brilliant. The "Orloff," a 193-carat stone, was in the scepter of the Emperor of Russia. The Russian treasury also contained the "Shah," an 86-carat stone. The "Koh-i-Nur," or "mountain of light," which weighed, when first brought to England, 1861, carats, but was reduced by recutting in 1852 to 1061 carats, is among the English crown jewels. The "Victoria," a Cape diamond, weighed 4571 carats in the rough and 180 carats cut. The world's largest diamonds, the "Excelsior" and the "Cullinan," weighing in the rough, respectively, 199.04 grams (995.2 carats) and 621.2 grams (3.106 carats), are both South African, the former being found in 1893 and the latter in 1905. These have both been reduced in size by cutting, and glass models of some of the resultant stones are included in the collection of imitation stones. The largest diamond in America at the present time and the finest yellow diamond in the world is the "Tiffany," a flawless double-cut brilliant of a rich orange-yellow color. It was found in South Africa and weighs 125% carats.

Before the discovery of the Brazilian and African mines all diamonds were brought from India and Borneo. In India the diamond is met with at three principal localities. The first is in southern India, in the Madras Presidency, and embraces the districts of Kadapah. Bellary, Karnul, Kistna, and Godavari. This region includes the famous "Golconda" district, the name, however, being not that of a mine, but merely the general term for the market where diamonds were bought and sold. The second locality is farther north and includes a large tract between the Mahanadi and Godavari Rivers: it embraces Sambalpur and Waigarh, 80 miles southeast of Nagpur, as well as portions of the Province of Chutia Nagpur. The third region is in Bundelkhand, in central India, the principal working being near the city of Panna. The Indian diamonds were obtained in part from alluvial deposits and in part from a quartzose conglomerate; at Panna this conglomerate appears to be largely made up of fragments of a lower sandstone, which it has been suggested may represent the original matrix. The yield of the Indian mines, once so large, is at present very small. The principal Borneo locality is in the basin of the Kapoeas River, on the west side of the Ratoos Mountain, near the town of Pontianak.

The diamond deposits of Brazil were discovered in 1728 and were at one time very productive, although the yield is at present small. Near Diamantina in Minas Geraes the diamonds are obtained in part from river washings and in part from prairie washings. The river deposits consist of rolled quartz pebbles, mixed with or united by a ferruginous clay which rests usually on talcose clays. The more common associated minerals are rutile, hematite, ilmenite, quartz, kyanite.

tourmaline, gold, garnet, zircon, etc. In the prairie washings the diamonds occur in a conglomerate consisting of quartz fragments covered with a thin bed of sand or earth. This deposit affords the finest stones. Other Brazilian localities are those of Bagagem, at which place a 247½ carat stone was found, and at Abaethe, Minas Geraes. In Bahia diamonds are found at Lencães; along the river Cacholira, especially at Surua and Sinorca; they occur also on the Salobro and other branches of the Pardo River.

By far the greatest portion of diamonds now obtained come from South Africa, their discovery dating from 1867. The diamond workings are of two kinds, river diggings and dry diggings. The river diggings are in the gravel of the Vaal River from Potchefstroom down to its junction with the Orange River, and along the latter as far as Hopetown, the principal workings being along the Vaal between Klip Drift and its junction with the Hart River. The dry diggings are chiefly in Griqualand-West, south of the Vaal River, on the border of the Orange Free State, about 640 miles northeast of Cape Town. There are here a number of limited areas approximately spherical or oval in form, with an average diameter of some 300 yards, the entire production area being all within a circle having a radius of about 2 miles. These mines were originally worked as individual claims, but they are now all consolidated in one gigantic monopoly, which practically controls the diamond output of the world. Some idea of the enormous output of the region may be gained from the statement that from 1867 to 1887 over 33,000,000 carats, or more than 61 tons of diamonds were taken out, valued in the rough at \$225,000,000, and after cutting at \$450,000,000.

At the Kimberley mines the diamantiferous area is inclosed in a wall of nearly horizontal black carboniferous shale. The upper portion of the deposit consists of a friable mass of pale yellow color, called the "yellow ground." Below the reach of atmospheric influences the rock is more firm and of a bluish green color; it is called the "blue ground." This consists essentially of a serpentinous breccia inclosing fragments of carbonaceous shale, bronzite, diallage, garnet, magnetite, etc. The diamonds are rather abundantly distributed through the mass, often to the amount of four to six to the cubic yard. These areas are believed to be volcanic pipes, and the occurrence of the diamonds is obviously connected with the igneous intrusive, either being formed by the action of heat upon the carbonaceous shales, or being brought up from underlying rocks. (See pl. 14.)

For a detailed description of these occurrences the reader is referred to authoritative and comprehensive works like that of Mr. Gardner F. Williams (The Diamond Mines of South Africa), or M. DeLaunay (Les Diamants du Cap. Paris, 1897). Also reference should be

made to the very complete exhibit of rocks and minerals from the South African mines presented to the National Museum by Mr. Williams and described on page 134.

Diamonds were discovered in the Urals in 1829. They occur in the gold washings of the detritus along the Adolfskoi Creek, near Disersk, and elsewhere along the western declivity of the Uralian range. Australia they are found in the alluvial of the Cudgegong River, near Mudgee; and in the valley of the Horton River, in the Bingera district of New South Wales.

A few crystals have been occasionally met with in the United States in Rutherford, Franklin, Mitchell, and McDowell counties, North Carolina; in Hall County, Georgia; in Kentucky, Ohio, Wisconsin, Colorado, and Idaho; and in the placers of Eldorado, Amador, Nevada, Butte, Trinity, and Del Norte counties, California. In 1856 the Dewey diamond, weighing when cut 111 carats, was found at Manchester, near Richmond, Virginia.

Diamond-bearing peridotites are at present being exploited in Pike County, Arkansas, and in microscopic forms have been reported from a peridotite in British Columbia. The commercial possibilities of these sources have not as yet been demonstrated.

### LIST OF SPECIMENS.

INDIA.	
102 small stones and 17 chips; brilliant; colorless, very clear; total weight 18.25 carats. Gift of the Imam of Muscat	No. 1848
SOUTH AFRICA.	
Five rough crystals, 3 white, one yellow, one brown; total weight, 1.52 carats.  Gift of Gardner F. Williams	
UNION OF SOUTH AFRICA (KIMBERLEY, GRIQUALAND WEST).	
Partly cut; colorless; 1.67 carats; 5 by 5 by 5.  Uncut; gray; 1.6 carats; octahedron, 5 by 5 mm. The Shepard collection.  Brilliant, rectangular girdle; colorless; 0.928 carat; 6 by 5 by 4 mm  Brilliant, circular girdle; white; 0.25 carat; 4.5 by 3.5 mm. Isaac Lea collection  Brilliant, circular girdle; yellow; 0.19 carat; 4 by 3.5 mm. Isaac Lea collection  Brilliant, circular girdle; brown; 0.15 carat; 4 by 3 mm. Isaac Lea	No. 1001 No. 466 No. 470 No. 471
collection	No. 469
Brilliant, circular girdle; pink; 0.13 carat; 4 by 3 mm. Isaac Lea collection	
UNITED STATES.	
Kentucky.	
Cabin Fork Creek, near Montpelier, Adair County:	

Uncut but polished; yellow; 0.776 carat; 8 by 4 by 3 mm. Isaac Lea

### North Carolina.

Rutherford County:

Uncut; pale yellow; 0.14 carat; 3 mm. diameter; flattened octahedron.

Diopside.—See under Pyroxene.

Emerald.—See under Beryl.

### EPIDOTE.

Composition.—Calcium aluminum iron orthosilicate, Ca₂(Al,Fe)₃ (OH)(SiO₄)₃.

Crystallization.—Monoclinic.

Color.—Brown, green, green-yellow, or green-brown, owing to the presence of iron; strongly pleochroic, green to brown.

Luster.—Vitreous.

Hardness.—6.5; fairly durable.

Specific gravity.— $3.30 \pm 0.10$ .

Optical properties.—Mean refractive index 1.75; double refraction strong, 0.04; optically biaxial, negative.

With the microspectroscope epidote shows an absorption band in the violet. The color of the mineral is its most distinctive quality. It occurs in metamorphic rocks and in veins, and is little used as a precious stone owing to its intense color.

### LIST OF SPECIMENS.

### TYROL.

Essonite.—See under Garnet.

### EUCLASE.

Composition.—Beryllium aluminum orthosilicate, BeAl(OH) (SiO₄). Crystallization.—Monoclinic.

Color.—Colorless when pure, but often colored pale green or blue by traces of iron.

Luster.—Vitreous.

Hardness.—7.5; very durable.

Specific gravity.— $3.10 \pm 0.05$ .

Optical properties.—Mean refractive index 1.66; double refraction moderate, 0.02; optically biaxial, positive.

The mineral can be distinguished only by its optical properties. Occurs in metamorphic rocks such as mica schist, but it is rare and not widely used as a gem.

#### LIST OF SPECIMENS.

### BRAZIL.

### FELDSPAR.

Varieties.—This name includes several varieties, which are distinguishable by their crystallization and chemical composition, comprising albite, containing sodium (Na); labradorite, sodium and calcium (Na+Ca); microcline, potassium (K); oligoclase, sodium and calcium (Na+Ca); and orthoclase, potassium (K); and in addition several varieties based on peculiarities of structure or color, as amazonstone, adularia, moonstone, perthite, and sunstone.

Composition.—Silicates of potassium or sodium; in part, combinations of silicates of sodium with ortho-silicates of calcium, the element aluminum being present throughout. KAlSi₃O₈, NaAlSi₂O₈, and mNaAlSi₃O₈ + nCaAl₂(SiO₄)₂.

Crystallization.—Monoclinic or triclinic.

Color.—Colorless when pure; sometimes colored pink or green by impurities of unknown nature; in addition, may show internal reflection colors of two types, the one due to the presence of innumerable minute laminae, the other due to inclusions of hematite.

Luster.—Vitreous; transparent to translucent.

Hardness.-6; not very durable.

Specific gravity.—2.5 to 2.7.

Optical properties.—Mean refractive index, 1.53, varying from one kind of feldspar to another; optically biaxial.

The feldspars are distinguished by their optical properties, moderate hardness, pronounced cleavage, and peculiar color phenomena.

They are cut for the most part cabochon, to bring out color effects, and are classed as semiprecious stones. Only exceptionally fine stones are worth more than the cost of cutting. They are shown to best advantage in the varieties moonstone, orthoclase, and amazonstone.

#### LIST OF SPECIMENS.

### FELDSPAR, variety ADULARIA.

### SWITZERLAND (ST. GOTTHARD).

### FELDSPAR, variety AMAZONSTONE.

#### SIBERIA.

Rectangular slab; green; 110.45 carats; 72 by 40 by 4 mm. Gift of Clarence S. Bement		387
Three gems, two cabochon, one double cabochon; elliptical girdle; green	210.	•
and blue-green; 9.13, 6.77, and 5.03 carats; 22 by 17 by 4 mm., 17 by 13 by		
4 mm., 15 by 11 by 5 mm	No.	389
Cabochon, elliptical girdle; green; 5.79 carats; 18 by 13 by 3 mm. Isaac Lea		
collection	No.	388

UNITED STATES.		
Colorado.  Pikes Peak, El Paso County: Cabochon, elliptical girdle; green; two stones, 29.5 and 29.28 carats; 28 by 22 by 8 mm	No.	<b>39</b>
Pennsylvania.		
Media, Delaware County:  Elliptical disk; blue-green with pale yellow bands; 4.18 carats; 17 by 11 by 3 mm. Gift of Dr. Robert H. Lamborn		
carats; 45 by 34 by 12 mm. Isaac Lea collection	No.	392
·		
Amelia Courthouse, Amelia County: Cabochon, elliptical girdle; blue-green; 102.74 carats; 48 by 34 by 9 mm. Two cabochons, one circular, one elliptical girdle; green; 92.22 and 44.96 carats; 34 by 11 and 49.5 by 19 by 6 mm. Isaac Lea collection (fig. 9, pl. 7)		•
Six balls; pale blue; total weight, 14.36 carats; 7 mm. diameter; Isaac	110.	1203
Lea collection	No.	452
FELDSPAR, variety LABRADORITE.		
LABRADOR.		
Two knob-shaped pieces; dark gray-blue; 30.27 and 24.41 carats; 23 mm. diameter. Isaac Lea collection		396 408
Double cabochon, elliptical girdle; gray-brown; 19.18 carats; 26 by 20 by		
Cabochon, circular girdle; dark gray-green; 18.75 carats; 20 by 6 mm. Isaac	No.	406
Lea collection		395
Circular disk; dark gray with blue and green color; 17.535 carats; 22 by 4 mm.		407
Cabochon, rectangular girdle; dark gray-blue; 15.74 carats; 24 by 15 by 5 mm.		
Owl's head; dark gray-green; 4.59 carats; 12 mm. diameter	No.	394
FELDSPAR, variety MOONSTONE.		
(Albite and Oligoclase.)		
CEYLON.		
Double cabochon, long triangular girdle; colorless with pale blue internal color; 45.54 carats; 44 by 25 by 8 mm	No.	409
7.05, and 4.68 carats; 38 by 15 by 9, 14 by 11 by 6, and 12 by 5 mm. Isaac Lea collection	No.	398
Double cabochon, elliptical girdle; blue internal color; 12.55 carats; 15 by 12 by 10 mm	No.	400
Four cabochons, elliptical girdle; colorless; 8.9, 5.7, 4.76, and 2.7 carats; 16		
by 12 by 8, 17 by 10 by 5, 16 by 9.5 by 4, and 13 by 8 by 4.5 mm		411
Cabochon, elliptical girdle; colorless; 5.47 carats; 21.5 by 9 by 4 mm	No.	410
Cabochon, elliptical and circular girdles; colorless; lot of 110 gems, all small; total weight, 36.03 carats	No.	399

### INDIA.

Cabochon, elliptical girdle; colorless; 5.12 carats. Bequest, William H. Forwood	No.	401
TYROL.		
Cabochon, elliptical girdle; colorless with faint blue internal color; 14.79 carats; 22 by 14 by 8 mm	No.	417
UNITED STATES.		
Colorado.		
Cabochon, circular girdle; colorless; 0.95 carat; 7 by 3 mm	No.	402
Pennsylvania.		
Delaware County:  Tabular, diamond-shaped girdle; light gray showing blue internal color; 54 by 30 by 17 mm	No.	1204
weight, 0.57 carat; 6.5 by 4.5 by 2.5 and 4 by 2 mm. Isaac Lea collection	No.	1205
Media, Delaware County: Cabochon, rectangular girdle; colorless; 13.245 carats; 22 by 10 by 7 mm.	No.	1206
Virginia.		
Amelia Courthouse, Amelia County:  Cabochon, elliptical girdle; white with blue internal color; two gems, 84.05 and 61.9 carats; 46 by 30 by 8 and 37 by 25 by 9 mm  Cabochon, elliptical girdle; white, opaque; 27.89 carats; 30 by 16 by		
8 mm		
Double cabochon, elliptical girdle; white with blue internal color; 3.945 carats; 14 by 8 by 6 mm		
16 by 11 by 5.5 to 10 by 8 by 4 mm	No.	412
Hanover County:  Cabochon, elliptical girdle; colorless; 25.15 carats; 30 by 15 by 7.5 mm.  Gift of Clarence S. Bement	No.	1203
FELDSPAR, variety OLIGOCLASE.		
UNITED STATES.		
North Carolina.		
Hawk mine, near Bakersville, Mitchell County:  Step-brilliant, rectangular girdle; colorless; 6.03 carats; 14 by 10 by 6 mm.  Brilliant, square girdle; colorless; 2.4 carats; 8.5 by 6 mm		
FELDSPAR, variety ORTHOCLASE.		
MADAGASCAR.		
Brilliant, circular girdle; green-yellow; 60.96 carats; 26 by 18 mm. Isaac		
Lea collection	No.	1838
Brilliant, elliptical girdle; green-yellow; 17.9 carats; 20 by 15 by 10 mm.  Isaac Lea collection	No.	1820
Brilliant, octagonal girdle; pale yellow; 4.7 carats; 11 by 11 by 6 mm.  Isaac Lea collection	No.	1821

### FELDSPAR, variety PERTHITE.

### CANADA (PERTH, ONTARIO).

Cabochon, elliptical girdle; brown; 100.47 carats; 45 by 35 by 10 mm. Isaac		
Lea collection	No.	386
Cabochon, rectangular girdle; brown with white veins; 17.85 carats; 33 by 13		
by 5 mm	No.	385

### FELDSPAR, variety SUNSTONE.

#### NORWAY.

Cabochon, circular girdle; red-brown; two pieces; 20 and 18.5 carats; 23 by 6		
and 23 by 5.5 mm	No. 1196	8
Cabochon, rectangular girdle; red-brown; 7.93 carats; 32 by 9 by 3 mm	No. 1199	9
Four cabochons, one double cabochon, elliptical girdle; red-brown; 7.6		
carats to 2.4 carats; 17 by 13 by 5 to 9 by 8 by 4 mm. Isaac Lea collection	No. 1197	7
Double cabochon, elliptical girdle; red-brown; 5.26 carats; 14 by 11 by 5 mm.		
Isaac Lea collection	No. 1198	В
Three cabochons, two elliptical, one square girdle; dark gray, blue internal		
color; 11.08, 5.06, and 3.5 carats; 20 by 12 by 7, 14 by 10 by 4.5, and 11 by		
4 mm	No. 1200	0

### UNITED STATES.

### Pennsylvania.

Media, Delaware County:
Cabochon, elliptical girdle; two stones, one red-gray, one light gray;
56.37 and 19.67 carats; 43 by 32 by 6 mm. and 27 by 19 by 5.5 mm No. 1202
Tabular cabochon, rectangular girdle; gray with pale brown streaks;
6.77 carats; 19 by 11 by 3 mm. Gift of Dr. R. H. Lamborn No. 1201

### FLUORITE.

Sýnonym.—Fluor-spar.

Composition.—Calcium difluoride, CaF2.

Crystallization.—Isometric.

Color.—Colorless when pure, but usually showing disperse colors owing to the presence of submicroscopic particles of indeterminate nature; may be a beautiful yellow, green, blue, violet, or pink.

Luster.—Vitreous; transparent to translucent.

Hardness.—4; too soft for ordinary use as a precious stone, but can be used in ornaments, etc.

Specific gravity.— $3.18 \pm 0.05$ .

Opiical properties.—Refractive index, 1.434; optically isotropic; may show fluorescence or different colors when viewed by reflected and transmitted light, but never pleochroism.

The mineral is distinguished by its softness, by its lack of double refraction, and its easy and perfect octahedral cleavage. It occurs in veins in many kinds of rocks, including the pegmatites.

It is used for paper weights, vases, and other ornaments, chiefly as curiosities, and is worth little more than the cost of cutting. Small faceted stones are sometimes cut from this mineral, but are not sold commercially.

#### LIST OF SPECIMENS.

#### UNITED STATES.

### New Hampshire.

Chatham, Carroll County:

### Virginia.

Amelia Courthouse, Amelia County.

Step-brilliant, rectangular girdle; very pale smoky brown; 5.047 carats;

## GADOLINITE.

Composition.—Beryllium iron yttrium orthosilicate, Be₂FeY₂O₂ (SiO₄)₂.

Crystallization.—Monoclinic.

Color.—Black.

Luster.—Submetallic or brilliant vitreous; practically opaque except in very thin splinters.

Hardness.—6.5; fairly durable.

Specific gravity.  $-4.40 \pm 0.05$ .

Optical properties.—Mean refractive index, 1.80; optically biaxial, positive.

Gadolinite can be distinguished from several minerals which it resembles only by chemical tests. It is sometimes cut brilliant, but its dark color prevents its extensive use as a precious stone, and it is worth little more than the cost of cutting.

#### LIST OF SPECIMENS.

### UNITED STATES.

#### Texas.

Burnet, Llano County:

Brilliant, circular girdle; black, opaque; 8.56 carats; 13 by 8 mm. Isaac

### GARNET.

There are three prominent groups of garnet with several subdivisions under each, many of these grading into each other. They are:

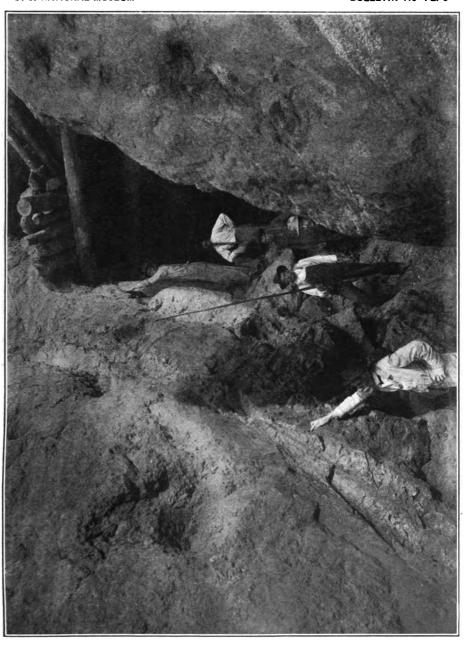
1. Aluminum garnet:

Grossularite.—Lime-aluminum garnet.

Pyrope.—Magnesium-aluminum garnet.

Almandite and rhodolite.—Iron-aluminum garnet.

Spessartite.—Manganese-aluminum garnet.



- 2. Iron garnet: Andradite.—Calcium-iron garnet.
- 3. Chromium garnet: Ouvarovite.—Calcium-chromium garnet.

The lime-aluminum garnet has a hardness of 7, a specific gravity of 3.55 to 3.66, and a considerable color range. The several varieties are: Essonite (cinnamon stone or hyacinth), of which the specimens of a clear yellow-brown to deep gold tinged with brown are more commonly used as gems. Grossularite includes the pale green, yellow to nearly white, pale pink, red-orange, and brown kinds. Romanzovite is a brown variety; wiluite is yellow-green to greenish white; topazolite is deep to pale yellow; and succinite is amber-colored.

The principal magnesian garnet is the pyrope, meaning "fire-like," a deep red to nearly black stone, prized as a gem. It is among the hardest of the garnets, ranking 7.5 in the scale. Its specific gravity lies between 3.7 and 3.8.

The almandite, or carbuncle, and rhodolite are iron-aluminum garnets. Almandite varies in color from bright red to deep red of several tints, occasionally assuming an orange hue by artificial light. The color of the rhodolite lies between a violet-purple and a brown-red. These varieties have a hardness of about 7.5, with a specific gravity seldom less than 4, and occasionally as high as 4.3. Both are prized as gems.

Spessartite is a manganese-aluminum garnet, varying in specific gravity from 3.7 to 4.3, and has a hardness of about 7. The color varies from a red-brown, sometimes with a tinge of violet, to orange red. It often affords fine gems.

The calcium-iron garnet varies in specific gravity between 3.6 and 4 and in hardness from 5 to 7. The group includes a diversity of forms, varying widely in color and other respects, the more important of which are: Andradite, a yellow or orange-brown variety; demantoid, or Uralian emerald, a grass-green, emerald-green, or brown-green stone having a brilliant luster, and when cut exhibiting considerable fire, especially by artificial light; colophonite, a brown-black garnet, characterized by a resinous luster; and melanite, a black to yellow-brown kind.

The calcium-chromium garnet, ouvarovite, is almost invariably a fine emerald green color, and is harder than any of the other varieties, ranking nearly 8 in the scale.

Garnet is common in mica, hornblende, and chlorite schist, gneiss and granite, occurring also in limestone, serpentine, and volcanic rocks (fig. 6). The garnet of granite, gneiss, mica schist, and similar rocks is commonly almandite. Grossularite is common in limestones and crystalline schists. Pyrope belongs especially to peridotites and the serpentines derived from them; occurs also in basalts. Spessartite occurs in granitic rocks, in quartzite, in certain schists, and in some rhyolites. Iron garnets are common in eruptive rocks, occurring also as a product of contact meta-

morphism. Demantoid occurs in serpentine. The chrome garnets belong particularly to serpentine; found also in granular limestone.

The mineral is widely used as a semiprecious stone, although the color is in some cases so deep that it is not much in favor. The most noted garnet region of the world is that some 60 kilometers north of Prague in Bohemia. For many years this has been almost the only commercial source of the common ruby garnet found mounted in various and multiple forms in the jewelers' shops.

Of late years a great many very beautiful garnets have been brought in from the Indian Reservations in Arizona and New Mexico, where they are gathered from the loose sands and gravels which result from

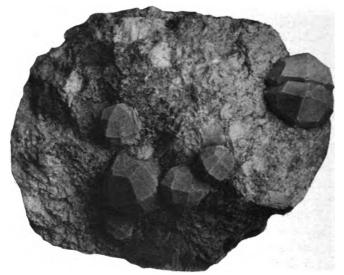


FIG. 6.-GARNETS IN MATRIX.

a decomposition of boulders of garnetiferous gneiss which, according to Gregory, have been brought from an unknown depth to the surface by igneous injections. These are often of no mean quality and are popularly spoken of as Arizona rubies. The principal localities are the Mule Ear and Moses Rock fields in southern Utah and the Garnet Ridge field in the adjoining portion of Arizona.

LIST OF SPECIMENS.

### GARNET, variety ALMANDITE.

#### BOHEMIA.

Cabochon, irregular elliptical girdle; violet-red; 24.42 carats; 25 by 13 by 6	
mm. Isaac Lea collection	969
Cabochon, elliptical girdle; violet-red; 23.2 carats; 24 by 13 by 7 mm. Isaac	
Les collection	<b>96</b> 8

¹ Economic Geology, vol. 11, 1916, p. 224.

Cabochon, pear-shaped girdle; violet-red; 21.37 carats; 23 by 13 by 7 mm.		
Isaac Lea collection	No.	970
Cabochon, elliptical girdle; violet-red; 15.347 carats; 18 by 12 by 6 mm.  Isaac Lea collection	No	971
Cabochon, elliptical girdle; violet-red; 10.79 carats; 15 by 12 by 6 mm.	110.	J, 1
Isaac Lea collection	M.	079
Rose-shell, elliptical girdle; brown-red; 9.13 carats; 15 by 13 by 5 mm.	NO.	973
Isaac Lea collection.		972
Rose, square girdle; brown-red; 6.46 carats; 11 by 6 mm. Isaac Lea collection.	No.	975
Cabochon, elliptical girdle; violet-red; 6.36 carats; 12 by 9 by 5 mm. Isaac Lea collection	No.	976
Rose-shell, circular girdle; brown-red; 6.08 carats; 13 by 4 mm. Isaac Lea		
collection	No.	974
Cabochon, elliptical girdle; violet-red; 3.97 carats; 12 by 10 by 3 mm. Isaac		
Les collection	No.	982
Step-brilliant, pear-shaped girdle; brown-red; 3.34 carats; 13 by 10 by 4 mm.		
Isaac Lea collection	No.	977
Step-brilliant, oval girdle; brown-red; 2.74 carats; 10 by 7.5 by 4 mm.		
Isaac Lea collection.	No.	978
Step-brilliant, elliptical girdle; violet-red; 2.62 carats; 11 by 8.5 by 4 mm.		
Isaac Lea collection	No.	979
Cabochon, elliptical girdle; violet-red; 2.49 carats; 12 by 8 by 2 mm. Isaac		
Les collection	No.	984
Cabochon, irregular elliptical girdle; violet-red; 2 carats; 10 by 6 by 2.5 mm.		
Isaac Lea collection	No.	986
Cabochon, elliptical girdle: violet-red; 1.66 carats; 8 by 7 by 2 mm.		
Isaac Lea collection	No.	985
Cabochon, elliptical girdle; violet-red; 1.65 carats; 8 by 6 by 3 mm. Isaac		
Lea collection	No.	983
Step, square girdle; brown-red; 1.63 carats; 7 by 3 mm. Isaac Lea collection.	No.	980
Cabochon, elliptical girdle; violet-red; 1.58 carats; 8 by 6 by 3 mm. Isaac		
Lea collection	No.	989
Cabochon, circular girdle; violet-red; 1.43 carats; 7 by 3 mm. Isaac Lea		
collection.	No.	981
Brilliant, elliptical girdle; violet-red; 1.41 carats; 10 by 8 by 2 mm. Isaac	••	
Lea collection	No.	993
Cabochon, elliptical girdle; violet-red; 1.38 carats; 8 by 7 by 2 mm. Isaac		
Lea collection	No.	987
Cabochon, circular girdle; violet-red; 1.245 carats; 7 by 2 mm. Isaac Lea		
collection	No.	988
Cabochon, elliptical girdle; violet-red; 1.06 carats; 8 by 6 by 2 mm. Isaac		
Lea collection	No.	992
Rose, pear-shaped girdle; deep red; 0.48 carat; 6 by 5 by 1.5 mm. Isaac Lea collection	No	000
COLOC MODEL	110.	350
CEYLON.		
Cabochon, oval girdle; violet-red; 10.4 carats; 17 by 9 by 6 mm	No.	920
Cabochon, elliptical girdle; violet-red; 10 carats; 16 by 10 by 7 mm	No.	919
Cabochon, oval girdle; violet-red; 8.96 carats; 15 by 9 by 6 mm. (polished	_,,,,	010
pebble)	No	921
Cabochon, elliptical girdle; violet-red; 8 carats; 16.5 by 8 by 6 mm	No.	922
Brilliant, circular girdle; violet-red; 1.95 carats; 8 by 3 mm. Isaac Lea col-	110.	344
	No	094
AVA-MAVILLA A A A A A A A A A A A A A A A A A A	180.	21.64

Brilliant, elliptical girdle; violet-red; 1.59 carats; 8 by 7 by 2 mm. Isaac Lea collection	No.	923
Brilliant, pear-shaped girdle; violet-red; 1.33 carats; 8 by 6 by 3 mm. Isaac Lea collection		
Brilliant, elliptical girdle; violet-red; 1.23 carats; 8 by 7 by 2 mm. Isaac		•
Lea collection	No.	930
Lea collection	No.	925
Brilliant, elliptical girdle; violet-red; 0.99 carat; 8 by 6 by 1.5 mm. Isaac		
Lea collection	No.	931
Lea collection.	No.	932
Brilliant, square girdle; violet-red; 0.625 carat; 5 by 2 mm. Isaac Lea col-		
lection	No.	926
Lea collection	No.	933
Brilliant, elliptical girdle; violet-red; 0.535 carat; 5.5 by 5 by 2 mm. Isaac		
Lea collection	No.	926
Isaac Lea collection	No.	927
Brilliant, square girdle; violet-red; 0.4 carat; 4 by 2 mm. Isaac Lea col-		
lection	No.	929
CHINA (TUNGCHOW, SHANTUNG PROVINCE).		
Cabochon, elliptical girdle; deep red; 19.416 carats; 23 by 15 by 8 mm $\dots$	No.	1207
INDIA.		
Rose-shell, elliptical girdle; brown-red; 57.46 carats; 31 by 27 by 9 mm	No.	833
Rose-shell, circular girdle; brown-red; 24.33 carats; 20 by 8 mm	No.	834
Rose-shell, rectangular girdle; brown-red; 23.98 carats; 19 by 17 by 10 mm.		835
Rose, elliptical girdle; brown-red; 19.82 carats; 18 by 17 by 7 mm		838
Rose-shell, elliptical girdle; brown-red; 14.5 carats; 21 by 17 by 7 mm		836
Rose, circular girdle; brown-red; 14.387 carats; 15 by 7 mm		84
Rose, elliptical girdle; brown-red; 13.62 carats; 18 by 15 by 6 mm		839
Brilliant, elliptical girdle; violet-red; 12.8 carats; 15 by 13 by 7 mm		840
Brilliant, irregular girdle; violet-red; 12.45 carats; 15 by 14 by 7 mm		84
Rose-shell, elliptical girdle; brown-red; 12.04 carats; 10 by 17 by 6 mm		837
Brilliant, rectangular girdle; brown-red; 11.045 carats; 13 by 12 by 8 mm.		85
Rose-shell, elliptical girdle; brown-red; 10.96 carats; 16 by 14 by 7 mm		842
Rose, elliptical girdle; brown-red; 10.09 carats; 15 by 13 by 6 mm		847
Rose, elliptical girdle; brown-red; 9.87 carats; 15.5 by 14 by 5 mm		844
Brilliant, irregular oval girdle; violet-red; 9.7 carats; 14 by 13 by 5 mm		848
Rose, pear-shaped girdle; brown-red; 9.375 carats; 16 by 13 by 5 mm		854
Rose-shell, circular girdle; brown-red; 9.167 carats; 15 by 7 mm		843
Rose, pear-shaped girdle; brown-red; 9.147 carats; 17 by 12 by 5 mm		846
Rose-shell, elliptical girdle; brown-red; 9.04 carats; 14 by 13 by 6 mm		
Rose, pear-shaped girdle; brown-red; 8.3 carats; 21 by 11 by 5 mm		879
Rose, pear-shaped girdle; brown-red; 7.12 carats; 20 by 10 by 5 mm		880
Rose-shell, elliptical girdle; violet-red; 6.8 carats; 18 by 15 by 5 mm		878
Rose, circular girdle; brown-red; 6.46 carats; 11 by 4.5 mm		856
Rose-shell, circular girdle; brown-red; 5.5 carats; 13 by 4.5 mm		849
Step, rectangular girdle; brown-red; 5.35 carats; 13 by 10 by 5 mm		859
Rose, circular girdle; brown-red; 4.96 carats; 12 by 4 mm	NA	850
Rosa shall circular girdle: hrown red: 4 760 cerete: 12 hy 5 mm	No.	200

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Rose-shell, elliptical girdle; brown-red; 4.57 carats; 14 by 11 by 4 mm.... No. 881
Rose, elliptical girdle; brown-red; 3.19 carats; 12 by 9 by 3.5 mm....... No. 858
Step, rectangular girdle; brown-red; 3.07 carats; 9 by 8 by 4 mm......... No. 865
Step-brilliant, elliptical girdle; violet-red; 3.037 carats; 10.5 by 9 by 4.5
 Rose, elliptical girdle; brown-red; 2.97 carats; 11 by 9 by 3 mm........... No.
Step, rectangular girdle; violet-red; 2.637 carats; 11 by 8.5 by 4 mm..... No. 861
Step, rectangular girdle; violet-red; 2.477 carats; 10 by 8 by 3.5 mm..... No.
Step, rectangular girdle; violet-red; 2.465 carats; 10 by 7 by 4 mm...... No.
Brilliant, rectangular girdle; violet-red; 2.3 carats; 11 by 8 by 3 mm..... No.
Step-brilliant, rectangular girdle; violet-red; 2.02 carats; 10 by 8 by 4 mm. No.
Step-brilliant, pear-shaped girdle; violet-red; 1.7 carats; 11 by 8.5 by 2.5 mm No.
Step-brilliant, rectangular girdle; violet-red; 1.69 carats; 9 by 7.5 by 4 mm. No. 869
Step-brilliant, pear-shaped girdle; violet-red; 1.525 carats; 10.5 by 8 by
  Step-brilliant, pear-shaped girdle; violet-red; 1.5 carats; 10.5 by 8 by 2 mm. No.
Step-brilliant, pear-shaped girdle; violet-red; 1.485 carats; 11 by 8 by 2
  901
Step-brilliant, pear-shaped girdle; violet-red; 1.48 carats; 11 by 8 by 2 mm. No.
Step-brilliant, rectangular girdle; violet-red; 1.41 carats; 8 by 6.5 by 3 mm. No.
Step-brilliant, pear-shaped girdle; violet-red; 1.40 carats; 10 by 7 by 2 mm.. No.
Step-brilliant, rectangular girdle; violet-red; 1.37 carats; 8 by 6 by 3 mm..... No. 875
Step-brilliant, pear-shaped girdle; violet-red; 1.35 carats; 10 by 7 by 2 mm.. No.
Step-brilliant, pear-shaped girdle; violet-red; 1.345 carats; 10 by 7 by 2 mm. No. 898
Step-brilliant, rectangular girdle; violet-red; 1.33 carats; 8 by 7 by 3 mm... No. 872
Step-brilliant, pear-shaped girdle; violet-red; 1.315 carats; 10 by 8 by 2 mm. No. 905
Step-brilliant, pear-shaped girdle; violet-red; 1.275 carats; 10 by 7 by 2 mm. No. 885
Step-brilliant, rectangular girdle; violet-red; 1.27 carats; 7.5 by 6.5 by 2.5 mm. No. 871
Step-brilliant, pear-shaped girdle; violet-red; 1.27 carats; 10 by 8 by 2 mm.. No.
Step-brilliant, pear-shaped girdle; violet-red; 1.265 carats; 9 by 9 by 2 mm. No.
Step-brilliant, pear-shaped girdle; violet-red; 1.255 carats; 10 by 7 by 2 mm. No.
Step-brilliant, pear-shaped girdle; violet-red; 1.255 carate; 10 by 7 by 2 mm. No.
Step-brilliant, pear-shaped girdle; violet-red; 1.25 carats; 10 by 7 by 2 mm.. No.
Step-brilliant, rectangular girdle; violet-red; 1.245 carats; 8 by 6 by 3 mm.. No.
Step-brilliant, pear-shaped girdle; violet-red; 1.24 carats; 10 by 7.5 by 2 mm. No.
Step-brilliant, rectangular girdle; violet-red; 1.225 carats; 8 by 7 by 3 mm.... No. 873
Step-brilliant, rectangular girdle; violet-red; 1.214 carats; 8 by 6 by 3 mm.. No. 874
Step-brilliant, rectangular girdle; violet-red; 1.19 carats; 7.5 by 6 by 4 mm.. No. 877
Step-brilliant, pear-shaped girdle; violet-red; 1.165 carats; 9 by 7.5 by 2 mm. No.
Step-brilliant, pear-shaped girdle; violet-red; 1.16 carats; 10 by 8 by 2 mm.. No. 891
Step-brilliant, pear-shaped girdle; violet-red; 1.15 carats; 10 by 7 by 2 mm.. No.
Step-brilliant, pear-shaped girdle; violet-red; 1.145 carats; 11 by 7 by 2 mm. No.
Step-brilliant, pear-shaped girdle; violet-red; 1.14 carats; 9 by 7.5 by 2 mm. No.
Step-brilliant, pear-shaped girdle; violet-red; 1.095 carats; 10 by 8 by 2 mm. No.
Step-brilliant, pear-shaped girdle; violet-red; 1.09 carats; 10 by 7.5 by 2 mm. No.
Step-brilliant, pear-shaped girdle; violet-red; 1.085 carats; 10 by 7 by 2 mm. No. 896
Step-brilliant, pear-shaped girdle; violet-red; 1.08 carats; 9 by 8 by 2 mm... No. 911
Step-brilliant, pear-shaped girdle; violet-red; 1.07 carats; 9 by 7 by 2 mm... No.
Step-brilliant, pear-shaped girdle; violet-red; 1.06 carats; 9.5 by 7.5 by 2 mm. No.
Step-brilliant, pear-shaped girdle; violet-red; 1.00 carat; 9 by 7 by 2 mm... No. 884
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Can bellion and deal deal of the second 10 by 7 by 1 5 and	<b>3</b> 7.	000
Step-brilliant, pear-shaped girdle; violet-red; 0.98 carat; 10 by 7 by 1.5 mm Step-brilliant, pear-shaped girdle; violet-red; 0.98 carat; 10 by 7 by 2 mm	No.	900 902
		910
Step-brilliant, pear-shaped girdle; violet-red; 0.98 carat; 9 by 7 by 2 mm Step-brilliant, pear-shaped girdle; violet-red; 0.975 carat; 9 by 7 by 2 mm		908
Step-oriniant, pear-shaped girdle; violet-red; 0.97 carat; 9 by 7 by 2 mm		909
Step-brilliant, pear-shaped girdle; violet-red; 0.875 carat; 9.5 by 7 by 1.5		303
mm		912
Madras:		
Cabochon, elliptical girdle; violet-red; 20.54 carats; 19 by 11 by 9 mm		
Cabochon, ellipsoid; violet-red; 11.02 carate; 23 by 9 by 5.5 mm	No.	918
. JAPAN.		
Brilliant, elliptical girdle; violet-red; 2.385 carats; 10 by 7 by 3 mm	No.	1210
Brilliant, pear-shaped girdle; violet-red; 2.335 carats; 11 by 7 by 4 mm		
Brilliant, elliptical girdle; violet-red; 2.235 carats; 9 by 6 by 4 mm. Isaac		
Lea collection.	No.	1213
Brilliant, pear-shaped girdle; violet-red; 2.125 carats; 10 by 7 by 4 mm.		
Isaac Lea collection	No.	1214
Brilliant, pear-shaped girdle; violet-red; 1.955 carats; 10 by 6 by 3 mm	No.	1209
Brilliant, pear-shaped girdle; violet-red; 1.91 carats; 8 by 7 by 4 mm.		
Isaac Lea collection	No.	1215
Brilliant, elliptical girdle; violet-red; 1.865 carats; 7.5 by 7 by 2 mm. Isaac		
Lea collection.	No.	1216
Cabochon, oval girdle; violet-red; 1.855 carats; 9 by 8 by 3 mm. Isaac Lea		
collection	No.	1217
Brilliant, elliptical girdle; violet-red; 1.81 carats; 8 by 6.5 by 3.5 mm.	BT.	1010
Isaac Lea collection	No.	1218
collection	No.	1910
Cabochon, irregular oval girdle; violet-red; 1.69 carats; 8 by 7 by 3 mm.	NO.	1419
Isaac Lea collection	No.	1220
Brilliant, pear-shaped girdle; violet-red; 1.64 carats; 8 by 6 by 4.5 mm.	2.0.	
Isaac Lea collection	No.	1221
Brilliant, elliptical girdle; violet-red; 1.635 carats; 8.5 by 5 by 4 mm.		
Isaac Lea collection	No.	1222
Brilliant, elliptical girdle; violet-red; 1.555 carats; 10 by 6 by 2 mm		
Brilliant, pear-shaped girdle: violet-red; 1.545 carats; 7 by 6 by 4 mm.		
Isaac Lea collection	No.	1223
Rose, pear-shaped girdle; violet-red; 1.505 carats; 10 by 8 by 2 mm. Isaac		
Les collection		
Step, elliptical girdle; violet-red; 1.5 carats; 8 by 6 by 2 mm		1212
Cabochon, irregular oval girdle; violet-red; 1.465 carats; 8 by 7 by 3 mm.		
Isaac Lea collection	No.	1225
Cabochon, irregular oval girdle; violet-red; 1.425 carats; 9 by 7 by 2 mm.	37	3000
Isaac Lea collection	No.	1226
Step-brilliant, elliptical girdle; violet-red; 1.325 carats; 9 by 6 by 2 mm.  Isaac Lea collection	NT.	1 007
Isaac Lea collection	110.	1221
Step-brilliant, elliptical girdle; brown-red; 1.27 carats; 9 by 7 by 2 mm.  Isaac Lea collection	No	1222
Brilliant, elliptical girdle; violet-red; 1.23 carats; 7 by 5 by 3.5 mm. Isaac	410.	
Lea collection	No.	1229
Half-brilliant; pear-shaped girdle; brown-red; 1.025 carats; 9 by 7.5 by 1.5		
mm. Isaac Lea collection		1230

### TYROL.

Cabochon, circular girdle; brown-red; 4.48 carats; 11 by 5 mm	No.	994
Rose, pear-shaped girdle; brown-red; 3.89 carats; 15 by 8 by 4 mm	No.	995
Rose, circular girdle; brown-red; 1.55 carats; 8 by 3 mm	No.	996
Rose, circular girdle; brown-red; 1.11 carats; 7 by 3 mm		
Rose, rectangular girdle; brown-red; 0.745 carat; 6 by 5 by 3 mm	No.	998
Rose, square girdle; brown-red; 0.635 carat; 5 by 2 mm	No.	999
UNITED STATES.		
Arizona.		
Fort Defiance, Apache County:		
Brilliant, circular girdle; deep red; 3.386 carats; 10 by 5 mm	No.	1236
Gift of Frank Springer	No.	1241
Brilliant, circular girdle; deep red; 2.15 carats; 8 by 5 mm. Gift of Frank Springer	No.	1242
Brilliant, circular girdle; deep red; 1.97 carats; 8 by 4 mm. Gift of		
Frank Springer	No.	1243
Step-brilliant, rectangular girdle; deep red; 1.675 carate; 8 by 7 by		
4 mm	No.	1237
Brilliant and step-brilliant, circular girdle; three gems, two deep red, one violet-red; 1.31, 1.18, and 1.15 carats; 7 by 3 and 7 by 4 mm.		
Gift of Frank Springer	No.	1244
Brilliant, rectangular girdle; deep red; 1.085 carats; 7 by 5 by 4 mm		
Brilliant, circular girdle; deep red; 0.83 carat; 6 by 4 mm		
Brilliant, circular girdle; deep red; 0.775 carat; 6 by 4 mm	No.	1239
New Mexico.		
Brilliant, square girdle; deep violet-red; 1.405 carats; 8 by 3 mm. Isaac		
Lea collection	No.	663
Brilliant, square girdle; red-brown; 1.315 carats; 6 by 5 mm. Isaac Lea collection.		
Brilliant, elliptical girdle; deep violet-red; 1.16 carats; 8 by 6.5 by 3 mm.	110.	004
Isaac Lea collection	No.	665
Brilliant, square girdle; deep violet-red; 1.095 carats; 6.5 by 3 mm. Isaac		000
Lea collection	No.	666
Brilliant, circular girdle; deep violet-red: 0.78 carat; 5.5 by 3 mm. Isaac		
Lea collection.	No.	667
Brilliant, circular girdle; deep violet-red; 0.615 carat; 5 by 3 mm. Isaac Lea collection	No.	668
Step-brilliant, elliptical girdle; deep violet-red; 0.55 carat; 5.5 by 5 by 3		
		660
mm. Isaac Lea collection		669
		669
mm. Isaac Lea collection	No.	
mm. Isaac Lea collection	No.	
mm. Isaac Lea collection.  North Carolina.  Step-brilliant, rectangular girdle; light violet-red; 1.58 carats; 7.5 by 6 by 4 mm  Macon County: Hollow cabochon, pear-shaped girdle; deep red; 5.67 carats; 14 by 10	No.	1235
mm. Isaac Lea collection.  North Carolina.  Step-brilliant, rectangular girdle; light violet-red; 1.58 carats; 7.5 by 6 by 4 mm.  Macon County:	No.	1235

# Pennsylvania.

Green's Creek, Delaware County:  Cabochon, circular girdle; deep red; 4.345 carats; 9 by 5 mm  Cabochon, elliptical girdle; deep red; 3.65 carats; 12 by 8 by 4 mm		
LOCALITY NOT RECORDED.		
Cabochon, elliptical girdle; violet-red; 13.252 carats; 18 by 13 by 6 mm.  Isaac Lea collection	No.	93
Step-brilliant, elliptical girdle; violet-red; 5.77 carats; 20 by 8 by 5 mm.  Isaac Lea collection		936
Step, circular girdle (intaglio); deep violet-red; 5.6 carats; 12 by 4.5 mm		670
Cabochon, elliptical girdle; brown-red; 4.47 carats; 12 by 10 by 3 mm.  Isaac Lea collection	No	938
Step-brilliant, elliptical girdle (intaglio); violet-red; 3.67 carats; 12 by 8 by		330
5 mm	No.	96
Brilliant, elliptical girdle; violet-red; 2.6 carats; 17 by 7 by 3.5 mm. Isaac Lea collection	No.	937
Step, octagonal girdle; brown-red; 2.089 carats; 11 by 8 by 2.5 mm. Isaac		
Lea collection	No.	939
Isaac Lea collection	No.	94]
Cabochon, circular girdle (intaglio); violet-red; 1.68 carats; 8 by 3 mm	No.	960
Cabochon, elliptical girdle; violet-red; 1.61 carats; 9 by 7 by 2 mm. Isaac Lea collection	No.	944
Step-brilliant, elliptical girdle; violet-red; 1.6 carats; 9 by 7 by 3.5 mm.		
Isaac Lea collection	No.	940
Isaac Lea collection	No.	946
Cabochon, irregular elliptical girdle; violet-red; 1.30 carats; 8 by 6 by 2	37.	056
mm. Isaac Lea collection	No.	953
Isaac Lea collection		942
Cabochon, circular girdle (intaglio); violet-red; 1.187 carats; 7 by 2 mm Step, octagonal girdle; brown-red; 1.15 carats; 6.5 by 6 by 3.5 mm. Isaac	No.	967
Lea collection	No.	943
Cabochon, elliptical girdle; violet-red; 1.055 carats; 8 by 5 by 2 mm.	<b>3</b> 7 -	000
Isaac Lea collection		960
mm. Isaac Lea collection		950
Cabochon, irregular elliptical girdle; violet-red; 0.97 carat; 7 by 5 by 2 mm. Isaac Lea collection	No	949
Brilliant, pear-shaped girdle; violet-red; 0.955 carat; 11 by 5 by 2 mm.	110.	710
Isaac Lea collection	No.	959
Brilliant, elliptical girdle; violet-red; 0.9 carat; 8 by 7 by 2 mm. Isaac Lea collection		957
Step-brilliant, octagonal girdle; violet-red; 0.85 carat; 6 by 5 by 3 mm.		
Isaac Lea collection	No.	952
Lea collection	No.	962
Cabochon, irregular elliptical girdle; violet-red; 0.74 carat; 6 by 5 by 2 mm.	NI.	OF
Isaac Lea collection	140.	95
Lea collection	No.	94

Cabochon, circular girdle; violet-red; 0.55 carat; 5 by 2 mm. Isaac Lea		
collection	No.	956
Cabochon, irregular elliptical girdle; violet-red; 0.54 carat; 6 by 4.5 by 1.5	37	<b>0</b> F1
mm. Isaac Lea collection	No.	951
Isaac Lea collection	No.	948
Cabochon, pear-shaped girdle; violet-red; 0.32 carat; 7 by 4 by 1 mm.		
Isaac Lea collection	No.	961
Brilliant, elliptical girdle; brown-red; 0.235 carat; 5 by 4 by 1 mm. Isaac Lea collection	Nο	963
Step, irregular elliptical girdle; violet-red; 0.23 carat; 5 by 4 by 1.5 mm. Isaac Lea collection		947
Brilliant, elliptical girdle; brown-red; 0.185 carat; 5 by 4 by 1 mm. Isaac	210.	0
Lea collection	No.	964
Brilliant, square girdle; violet-red; 0.185 carat; 4 by 1 mm. Isaac Lea collection	Ma	OEO
Brilliant, rectangular girdle; violet-red; 0.185 carat; 4 by 3.5 by 1 mm.	No.	958
Isaac Lea collection	No.	954
GARNET, variety DEMANTOID.		
RUSSIA (NIZHNI-TAGILSK).		
Brilliant, circular girdle; brown-green; 3.1 carats; 8.5 by 6 mm	No.	142
Brilliant, rectangular girdle; deep yellow-green; 2.26 carats; 9 by 8.5 by		
4 mm		141 145
Step-brilliant, rectangular girdle; deep yellow-green; 1.00 carats; 7 by 5.5 by 3.5 mm.		
Brilliant, square girdle; deep yellow-green; 1 carat; 6 by 4 mm	No.	143 144
Brilliant, square girdle; light green; 0.337 carat; 5 by 2.5 mm		146
GARNET, variety ESSONITE.		
CEYLON.		
Step-brilliant, elliptical girdle; deep orange-brown; 64.17 carats; 30 by 24		
by 12 mm. Isaac Lea collection	No.	493
Step-brilliant, rectangular girdle; deep orange-brown; 5.7 carats; 12 by 11 by 5 mm	No	495
Step-brilliant, elliptical girdle; deep orange-brown; 5.68 carats; 14 by 11 by 5 mm.		
Brilliant, rectangular girdle; deep orange-brown; 3.89 carats; 11 by 10 by	210.	200
5.5 mm. Isaac Lea collection	No.	497
Step-brilliant, rectangular girdle; deep orange-brown; 3.7 carats; 10 by 8	N.	400
by 5 mm. Isaac Lea collection	No.	498
Isaac Lea collection	No.	499
Two gems, step-brilliant and brilliant, elliptical girdle; deep orange-brown;		
0.8 carat; 6.5 by 5 by 3 and 7 by 6 by 3 mm. Isaac Lea collection Eleven gems, brilliant and step-brilliant, irregular girdles; deep orange-	No.	500
brown; total weight, 3.6 carats; 5 by 3 to 3 by 2 mm. Isaac Lea collec-		
tion	No.	501
LOCALITY NOT RECORDED.		
Step, elliptical girdle (intaglio); orange-brown; 5.02 carats; 15 by 10 by 5		
mm	No.	494

# GARNET, variety GROSSULARITE.

CANADA	(HULL,	OTTAWA	COUNTY,	QUEBEC).
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Brilliant, square girdle; pale yellow; 1.24 carats; 7 by 4 mm	No. No.	13 13
MEXICO (XALOSTOC, MORELOS).		
Step-brilliant, rectangular girdle; deep rose pink; 1.2 carats; 7 by 6 by 4 mm. Step-brilliant, circular girdle; deep rose pink; 0.88 carat; 6 by 4 mm		
GARNET, variety PYROPE.		
BOHEMIA.		
Necklace of 103 rose cut and 2 cabochon; deep red. Isaac Lea collection Fifty gems, rose cut, circular and elliptical girdles; deep red; total weight, 12.275 carats; average size, 4 by 2 mm		
UNION OF SOUTH AFRICA.		
Six gems, brilliant, circular girdle; deep red; total weight, 2.34 carats; average size, 5 by 3 mm	Νo	464
UNITED STATES.	210.	
North Carolina.  Macon County:		
Brilliant, circular girdle; violet-red; 3.079 carats; 10 by 5 mm. Isaac Lea collection	No.	476
collection	No.	477
Lea collection	No.	478
Brilliant, circular girdle; deep red; 1.46 carats; 7 by 4.5 mm. Isaac Lea collection	No.	479
Brilliant, circular girdle; deep red; 1.45 carats; 7.5 by 4 mm. Isaac	M-	400
Lea collection		480
Lea collection	No.	481
Lea collection	No.	482
Brilliant, circular girdle; violet-red; 1.08 carats; 7 by 4 mm. Isaac Lea collection	No.	483
Brilliant, circular girdle; violet-red; 1.07 carats; 7 by 4 mm. Isaac Lea collection	No	484
Brilliant, circular girdle; violet-red; 1.06 carats; 7 by 4 mm. Isaac Lea collection		485
Brilliant, circular girdle; brown-red; 1.05 carats; 6.5 by 4 mm. Isaac		
Lea collection	No.	486
Isaac Lea collection	No.	487
Brilliant, circular girdle; violet-red; 0.915 carat; 6 by 4 mm. Isaac Lea collection		488
Brilliant, circular girdle; violet-red; 0.835 carat; 6 by 3.5 mm. Isaac		
Lea collection.	No.	489
Brilliant, circular girdle; deep violet-red; 0.74 carat; 6 by 4 mm. Isaac	No	<b>∡</b> 0∩

Macon County—Continued.		
Brilliant, circular girdle; deep red; 0.718 carat; 6 by 3.5 mm. Isaac  Lea collection	lo.	491
Brilliant, circular girdle; brown-red; 0.567 carat; 5 by 3.5 mm. Isaac Lea collection	lo.	492
GARNET, variety RHODOLITE.		
UNITED STATES.		
North Carolina.		
Step-brilliant, circular girdle; deep violet-red; two stones, 2.0 and 1.97 carats; each 7 by 5 mm. Isaac Lea collection	ío.	460
GARNET, variety SPESSARTITE.		
UNITED STATES.		
Virginia.		
Amelia Courthouse, Amelia County:		
Brilliant, circular girdle; orange-brown; 40.115 carats; 21 by 13 mm N	lo.	147
Brilliant, circular girdle; orange-brown; 11.8 carats; 14 by 8 mm N Step-brilliant, rectangular girdle; orange-brown; 12 by 11 by 8 mm.	lo.	152
Gift of Ira R. Allen N	lo.	154
Step-brilliant, rectangular girdle; orange-brown; 9.0 carats; 12 by 10		
by 7 mm. Gift of Ira R. Allen N		153
Brilliant, circular girdle; orange-brown; 7.44 carats; 11.5 by 8 mm N Cabochon, circular girdle; orange-brown; 5.797 carats; 11 by 5.5 mm.		148
Isaac Lea collection		155
Brilliant, circular girdle; orange-brown; 2.67 carats; 8 by 6 mm N		150
Brilliant, circular girdle; orange-brown; 2.49 carats; 8 by 5.5 mm N		149
Brilliant, circular girdle; orange-brown; 1.126 carate; 6 by 4 mm N	0.	151
GOLD.		

Native gold, either in the form of leaf, nugget, or embedded in quartz, is often used in the form of scarf or breast pins and is hence recognized here by a characteristic form. It ranks, however, more as a curiosity or souvenir than as a commercial article.

### LIST OF SPECIMENS.

Leaf gold mounted as a breastpin. California. Isaac Lea collection...... No. 1779

Graphic granite.—See under Miscellaneous on page 120.

Grossularite.—See under Garnet.

### GYPSUM.

Synonyms or varieties.—Alabaster, satin spar, selenite. Composition.—Hydrous calcium sulphate, CaSO₄.2H₂O. Crystallization.—Monoclinic.

Color.—White or colorless.

Luster.—Vitreous or silky in fibrous varieties; transparent to translucent.

Hardness.—2; entirely too soft to be used as a precious stone. Specific gravity.—2.32  $\pm 0.05$ .

Optical properties.—Mean refractive index, 1.525; double refraction weak, 0.009; optically biaxial, positive.

Method of identification.—Can be readily recognized by its softness. Gypsum occurs in great quantities interstratified with other sedimentary rocks, and the pure white varieties are worked under the name alabaster. Only the fibrous form, satin spar, is utilized as gem material and then only in small ornaments as statuettes, beads, etc. While the luster of the fibrous variety is attractive, its softness precludes its extensive use, and it brings little more than the cost of cutting.

### LIST OF SPECIMENS.

### GYPSUM, variety SATIN-SPAR.

#### ENGLAND.

Cabochon, elliptical girdle; white; 32.03 carats; 29 by 18 by 12 mm. Gif	t			
of Clarence S. Bement	. N	0.	378	3
Bridgeford:				
Two necklaces of 63 beads each, white, 8 mm, diameter	. N	0.	377	7

### HEMATITE.

Composition.—Iron sesquioxide, Fe₂O₃.
Crystallization.—Hexagonal (trigonal), rhombohedral.
Color.—Black; when finely powdered, red.
Luster.—Metallic; practically opaque.
Hardness.—6; fairly durable.
Specific gravity.—5.20 ± 0.10.

Optical properties.—Too opaque for determination of optical properties by ordinary means.

The mineral can be best distinguished from other black minerals by the color of its powder or its red "streak," made by rubbing it on unglazed porcelain. Occurs abundantly in beds and in veins and sedimentary rocks, but is too black for use as a precious stone. Is sometimes cut into beads, intaglios, etc., which have a value little more than cost of cutting.

### LIST OF SPECIMENS.

### ENGLAND.

Dividuality,		
Two intaglios, tabular, rectangular; black; 17.29 and 17.23 carats; 18 by 15 by 3 mm	No.	1245
Intaglio, tabular, rectangular; black; 11.67 carats; 16 by 11 by 3 mm	No.	1247
Cumberland:		
Necklace of 48 beads, spherical; black; 12 to 8 mm. diameter	No.	1246
Hiddenite.—See under Spodumene.		
Huntilite.—See under Miscellaneous on page 120.		
Hyacinth.—See under Zircon.		

### HYPERSTHENE.

Variety.—Bronzite.

Composition.—Magnesium and iron metasilicate, (Mg, Fe) SiO₃.

Crystallization.—Orthorhombic.

Color.—Black, with bronze internal color; pleochroism distinct under the microscope.

Luster.—Submetallic.

Hardness.—5.5; not very durable.

Specific gravity.— $3.50 \pm 0.20$ .

Optical properties.—Mean refractive index, 1.70; double refraction moderate, about 0.01; biaxial, negative.

Hypersthene and bronzite are members of the pyroxene family and are common constitutents of certain types of volcanic rocks. They occasionally afford material that can be cut and are of interest but of little use as precious stones; are sometimes cut cabochon as a curiosity.

#### LIST OF SPECIMENS.

### NORWAY (FREDRIKSVARN).

### IOLITE.

Synonyms.—Cordierite, dichroite, "water-sapphire."

Composition.—Magnesium aluminum metasilicate, Mg₄Al₈O₆(SiO₂)₁₀. Crystallization.—Orthorhombic.

Color.—Blue, usually somewhat smoky; strongly pleochroic, from yellow to blue.

Luster.—Vitreous; transparent.

Hardness.—7; a durable stone.

Specific gravity.— $2.65 \pm 0.05$ .

Optical properties.—Mean refractive index, 1.54; double refraction weak, 0.008; optically biaxial, negative.

The mineral occurs in pegmatite and in metamorphic rocks. When cut in such a direction that the blue color shows at the top, it is used to some extent as a precious stone. Its value is slight.

### LIST OF SPECIMENS.

### BAVARIA (BODENMAIS).

Rectangular block; violet-blue to yellow-gray; 7.45 carats; 11 by 9 by 6 mm.. No. 586 CEYLON.

# JADE.

Varieties.—Jadeite and nephrite.

Composition.—Jadeite, a mineral of the pyroxene group, is a sodium aluminum silicate (NaAl(SiO₃)₂) with a granular to fibrous but compact structure. Nephrite, a member of the amphibole group, is a magnesium calcium silicate (Mg₃CaSi₄O₁₂) with a fibrous structure.

Crystallization.—Monoclinic.

Color.—Gray or white when pure; often green, owing to the presence of small amounts of iron silicates; usually mottled because of irregular distribution of the coloring substance.

Luster.—Vitreous; translucent.

Hardness.—6.5; can not be scratched by a knife, and fairly durable. Specific gravity.— $3.35 \pm 0.10$ .

Optical properties.—Mean refractive index for nephrite, 1.61; for jadeite 1.67.

Distinguished from imitations by its great hardness. True jade is not produced artificially, but green glass made cloudy by stirring in some pigment is sometimes used as an imitation. Not used as a precious stone in the ordinary sense, but, because of its hardness and toughness, has been much used, particularly by the Chinese, for ornaments, carvings, etc. The hardness renders work upon it difficult, and causes genuine jade articles to bring high prices. Ignorant buyers are often imposed upon by the substitution of a green serpentine for the real article. Jadeite can usually be distinguished from nephrite by its granular structure, nephrite being more distinctly fibrous.

### LIST OF SPECIMENS.

### JADE, variety JADEITE.

### CHINA.

Carved buckle; bright green; 68 by 18 mm. Isaac Lea collection	No. 1813
Clasp of gold containing two pieces of green jadeite, 27 by 12 mm., at ends, and one of pink tourmaline, 42 by 25 mm., in center	
Carved pendant; green to light green; 16.9 carats; 26 by 15 mm. Isaac	
Lea collection (fig. 9, pl. 12)	No. 1814
Carved pendant; green; 18.9 carats; 25 by 12 mm. Isaac Lea collection	
(fig. 11, pl. 12)	No. 1815
Two stones, irregular cabochon; bright green; 7.5 and 7.14 carats; 14 by 11	
mm	No. 1191
Charm; pale green and white; 31 by 24 mm. Isaac Lea collection	No. 1816
JADE, variety NEPHRITE.	
CHINA.	
Disk with flower; gray-green; 5.5 cm. diameter. Gift of Clarence S. Bement.	No. 1186
Reclining figure; light gray-green; 5.5 by 3.2 cm. Deposited by P. L. Jouy.	

#### JAPAN.

JAPAN.
Ring; light gray-green, translucent; 7 cm. diameter
NEW ZEALAND.
Two cameos and one intaglio; rectangular girdle; dark green; 18 by 15, 15 by 12; 16 by 13 mm
Carved piece, book-shaped; 28 by 19 by 6 mm.; and two pear-shaped pendants, 6.4 and 5.5 cm. long; dark green
UNITED STATES.
Alaska.
One labret; olive-green; 9 cm. long
Two cabochons, rectangular girdle; dark green; 14.76 and 9.5 carats; 20 by
Pendant; three links carved from one piece; pale gray. Isaac Lea collection
Jadeite.—See under Jade.
Jasper.—See under Chalcedony.
KYANITE.
Synonym.—Often spelled cyanite.  Composition.—Aluminum oxy-orthosilicate, Al ₂ O ₃ (SiO ₄ ).  Crystallization.—Triclinic; habit bladed.  Color.—Colorless when pure; often blue owing to the presence of impurities of unknown nature.  Luster.—Vitreous; translucent to transparent.  Hardness.—7 in one direction, 5 in the other; not very durable.  Specific gravity.—3.60±0.05.  Optical properties.—Mean refractive index, 1.72; double refraction moderate, 0.015; optically biaxial, negative.  A great variation in hardness is highly characteristic. It is rarely found clear enough to be used as a precious stone, but is occasionally cut.
LIST OF SPECIMENS.
RUSSIA.
Step, rectangular girdle; blue; 0.579 carats; 7 by 4 by 2 mm
UNITED STATES.
North Carolina.
Spruce Pine, Mitchell County: Step, rectangular girdle; deep blue; 3.728 carats; 12 by 7 by 5 mm. Gift of D. A. Bowman
Kunzite.—See under Spodumene. Labradorite.—See under Feldspar. Lapis-lazuli.—See under Lazurite.

### LAZURITE.

Synonym.—Lapis-lazuli.

Composition.—The ornamental stone known as lapis-lazuli is a mixture of a number of different minerals, but the principal one, yielding the blue color, is lazurite, a sodium aluminum sulphoortho-silicate, Na₅Al₅S₂(SiO₄)₃.

Crystallization.—Isometric.

Color.—Deep blue, due to the peculiar sulphur compound present. Luster.—Vitreous; translucent.

Hardness.—5; rather too low for the stone to be durable.

Specific gravity.—2.40  $\pm$  0.10.

Optical properties.—Refractive index, 1.49; isotropic.

The composite nature of the rock can easily be made out by close examination, specks of pyrite in particular being almost always visible. It is decomposed by hydrochloric acid with the evolution of hydrogen sulphide. It occurs in metamorphic rocks. The artificial blue pigment known as ultramarine is essentially identical with lazurite in composition. Blue glass and blue stained chalcedony are often put on the market as imitations. Lapis-lazuli is used in the manufacture of ornaments of various kinds, and, being rather difficult to carve, brings fairly high prices. It does not occur in masses of large size. The only mineral with which it is likely to become confounded is sodalite (see p. 97).

# LIST OF SPECIMENS.

### CENTRAL ASIA.

### CHILE (ANDES MOUNTAINS).

Slab; oval; deep blue; 33.7 grams (168.6 carats); 65 by 35 by 7 mm......... No. 355 PERSIA.

Leopardite.—See under Miscellaneous (Porphyry) on page 120. Lintonite.—See under Thomsonite.

### MALACHITE AND AZURITE.

Composition.—Hydrous copper carbonate, Cu₂(OH)₂(CO₂).

Crystallization.—Monoclinic.
Color.—Brilliant green, characteristic of many copper compounds.

Luster.—Vitreous, or, in fibrous varieties, silky; practically opaque. Hardness.—3.5; can be used only where not subjected to wear.

Specific gravity.— $4 \pm 0.05$ .

Optical properties.—Mean refractive index, 1.88; double refraction extremely strong, 0.2; optically biaxial, negative.

The mineral dissolves with effervescence in hydrochleric acid, yielding a yellow solution which together with its color is sufficient in most cases for identification. Occurs like azurite in weathered copper ores, and is used for ornaments, especially table tops, etc., and was formerly valued very highly. As a rule, sound pieces of only moderate size are obtainable, and on the larger objects of art small pieces are very skillfully utilized as a thin veneer. Azurite is associated with malachite in the specimen figured below (fig. 7).

### LIST OF SPECIMENS. SIBERIA.

Cabochon, circular girdle; banded green and brown; 70.8 carats; 34 by 6 mm. Isaac Lea collection (fig. 3, pl. 7). No. 1250 Tabular, elliptical girdle; banded dark and light green; 63.7 carats; 40 by 32 by 4 mm...... No. 1248 Tabular, circular girdle; dark green with lightgreen concentric rings; 49.79 carats; 31 by 4 mm. No. 1249 Cabochon, elliptical girdle; dark and light green, banded; 42.67 carats; 33 by 26 by 5 mm. No. 1251



FIG. 7.-MALACHITE AND AZURITE.

Microcline.—See under Feldspar, variety Amazonstone.

### MOLDAVITE: TEKTITE.

Synonyms and varietal names.—Local names dependent upon sources are common, as Australites, billitonites, and obsidian bombs. Suess proposes the general name tektite for the entire group.

Composition.—Glass high in silica, alumina, and the alkalies.

Crystallization.—None; amorphous.

Color.—Green to black.

Luster.—Vitreous.

Hardness.—6 to 7.

Specific gravity.—2.31 to 2.5.

Optical properties.—Refractive index variable, mostly low; optically isotropic.

Resembles in many cases ordinary green bottle glass. Its lower index of refraction distinguishes it from any natural crystalline mineral. Found loose on surface or in gravels in various parts of Australia, Bohemia, and Moravia, and thought by some to be of artificial, and by others of meteoric origin. The green variety, moldavite, has sometimes been cut as a gem stone, but is of value only as a curiosity.

#### LIST OF SPECIMENS.

#### MORAVIA.

Two stones, step-brilliant and brilliant, elliptical and rectangular girdles; dark green; 23.11 and 4.95 carats; 24 by 17 by 11 and 13 by 10 by 7 mm... No. 681

Moonstone.—See under Feldspar.

Moss Agate.—See under Chalcedony.

Nephrite.—See under Jade.

### OBSIDIAN.

Synonyms or varieties.—Rhyolite glass, volcanic glass, hyaline rhyolite.

Composition.—Glassy volcanic rocks of variable composition, chiefly silicates of aluminum, iron, calcium, and the alkalies.

Crystallization.—None.

Color.—Various shades of black, brown, or red.

Luster.—Vitreous; transparent to translucent.

Hardness.-5.5.

Specific gravity.—Varying with composition, but mostly around 2.5.

Optical properties.—Refractive index variable, but mostly about 1.6; optically isotropic.

The resemblance to ordinary glass usually distinguishes this material from other stones, but its isotropic character and low index of refraction are usually confirmatory tests. Obsidian is of common occurrence in many volcanic regions, where it is a result of the rapid cooling of a molten magma that under different conditions might have become crystalline. Artificial glasses similar in appearance to obsidian can readily be prepared. The variegated and more brilliantly colored varieties have sometimes been cut, but the color is rarely sufficiently attractive to give it any value other than as a curiosity.

### LIST OF SPECIMENS.

MEXICO (AZTEC OBSIDIAN MINE, NEAR REAL DEL MONTE, HIDALGO).

### UNITED STATES.

# Wyoming.

Wyoming.		
Yellowstone National Park:		
Two stones, cabochon, rectangular girdle; brown-black; 28 by 21 by 7		
and 25 by 19 by 6 mm	No.	683
Two stones, cabochon, elliptical girdle; red-brown with black blotches;		
26 by 19 by 6 mm	No.	682
Two stones, cabochon, circular girdle; red-brown; 26 by 10 mm	No.	684
Two stones, cabochon, rectangular girdle; red-brown mottled with		
black; 22 by 18 by 10 mm	No.	686



Yellowstone National Park-Continued.

Cabochon, elliptical girdle; dark gray; 11 carats; 22 by 17 by 6 mm.

Oligoclase.—See under Feldspar.

Olivine.—See under Chrysolite.

Onyx.—See under Chalcedony.

### OPAL.

Composition.—Silica, containing a variable amount of water  $(SiO_2 + nH_2O)$ .

Crystallization.—None; amorphous.

Color.—Colorless when pure, but often tinted pink, blue, and even black by impurities; shows a very brilliant internal reflection color owing to the presence of innumerable minute laminae.

Luster.—Vitreous; transparent to translucent.

Hardness.—6; by reason of this moderate degree of hardness, its brittleness, and its porous nature, is not very durable under ordinary conditions of wear.

Specific gravity.— $2.1 \pm 0.1$ .

Optical properties.—Refractive index somewhat variable because of differences in water content, but chiefly about 1.40; optically isotropic except where irregular distribution of the water content causes strain phenomena, when double refraction may be observed.

No other precious stone approaches opal in the internal color, so that this property, together with the low specific gravity and index of refraction, serves to identify it.

There are many varieties to which specific names have been given. The precious opal exhibits a play of delicate colors, reflecting now one hue and then another. The harlequin opal presents a variegated play of colors on a reddish ground and resembles the fire opal. The fire opal presents red to yellow colors, with firelike reflections, somewhat irised on turning. Girasol is a blue-white translucent kind, presenting red reflections in a strong light. Lechosos opal is a name applied to those kinds showing deep green flashes of color. Hydrophane is a white or light colored opaque kind which becomes transparent when immersed in water. Cacholong is opaque porcelainwhite, blue-white, pale yellow, or red. Opal agate is agatelike in structure. Jasp-opal contains several per cent of iron, and is the analogue in opal of jasper in quartz. Wood opal is wood silicified by opal; sometimes called lithoxyle when showing a woody structure. Hyalite, or Muller's glass, is either colorless and pellucid like glass, or a translucent blue-white. Moss opal contains mosslike inclusions of manganese oxide and is the analogue in opal of the moss agate in

4555-22---7

quartz. Tabasheer is an amorphous, opal-like silica deposited within the joints of bamboo; it absorbs water and becomes transparent like hydrophane.

Opal occurs as a secondary deposit in fissures in many kinds of rocks, also in petrified wood and other fossil material, being deposited in the gelatinous form from solutions of silica, and hardening as water is gradually expelled. Material of the composition of opal can be readily produced artificially, but it has never proved possible to reproduce the brilliant internal color phenomena shown by the natural mineral. Opal is always cut cabochon to bring out the color to the best advantage, and, while not always of great value, it becomes at times one of the most beautiful and fascinating of gems and is correspondingly expensive.

The chief commercial sources are Australia, Hungary, and Mexico. Recently deposits in Nevada (pl. 9), have become important sources, producing black opals of extraordinary size and beauty.

### LIST OF SPECIMENS.

### AUSTRALIA.

Cabochon, elliptical girdle; blue and green; 31.96 carats; 33 by 16 by 10 mm. Isaac Lea collection	No.	1830
New South Wales.		
Slab, rectangular girdle; mosaic; 29 by 46 mm	No. 1	1042
Two cabochons, elliptical girdle; blue and pale yellow; 5.58 and 3 carats;		
20 by 10 by 4.5 and 14 by 10 by 4 mm. Gift of H. P. Petersen	No.	1082
Lightning Ridge: Six irregular fragments, polished; blue and green; greatest dimensions,		
38, 28, 25, 21, 21, and 19 mm	No.	1041
White Cliffs:		
Necklace of 50 graduated beads, separated by crystal beads; white with blue internal color; 9.5 to 4.5 mm. diameter	No.	1083
Cabochon, elliptical girdle; blue-green in brown matrix; 22.97 carats;		1044
24 by 19 by 8 mm		1044
mm		1047
Cabochon, elliptical girdle; blue-green and brown in matrix; 13.94		
carats; 17 by 15 by 6 mm	No.	1049
Cabochon, elliptical girdle; green and blue in matrix; 12.48 carats; 18		1045
by 15 by 7 mm		1049
mm		1050
Cabochon, elliptical girdle; green-blue and red in matrix; 11.58 carats;		
22 by 12 by 5 mm	No.	1046
Cabochon, elliptical girdle; violet-blue in matrix; 8.84 carats; 16 by 10		
by 7 mm.		1053
Cabochon, elliptical girdle; blue-green in brown matrix; 8.06 carats; 18 by 15 by 4 mm		1048

White Cliffs—Continued. Cabochon, elliptical girdle; blue-green-red in brown matrix; 7.93 carats; 16 by 10 by 6 mm	N-	1051
Cabochon, elliptical girdle; blue and green, in matrix; 6.91 carats; 14.5		
by 11 by 6 mm	No.	1052 1054
Queensland.		
Barcoo River:		
Carving in form of a pansy; blue-white with fine play of color; 9.26	37	
carats; 25 by 22 mm. Isaac Lea collection		
total weight, 9.225 carats; average size, 9 by 7 by 3 mm		
Two cameos representing flamingoes on limonite; green-blue		1056
Four polished pieces, rectangular; precious opal in limonite; total weight, 22.1 carats; 18 by 11 to 17 by 11 mm		1055
Eulo Mines, Queensland border;		
Cabochon, nearly heart-shaped girdle; red-blue-green; 7.86 carats; 17 by 15 by 7 mm. Isaac Lea collection	No	1100
Three cabochons, one double cabochon; elliptical, circular, and pear-shaped girdles; red-blue-green-yellow; 2.69, 2.145, 1.9, 1.06 carats;	110.	1162
12 by 9.5 by 4.5, 9 by 5, 11 by 7.5 by 4.5, and 10 by 6 by 3 mm.		
Isaac Lea collection	No.	1183
HONDURAS.		
Two cabochons, elliptical girdle; white with opalescent colors; 38.19 and		
18.22 carats; 33 by 21 by 8, 24 by 19 by 6 mm		1079
Six small cabochons, elliptical girdle; white with play of colors; total weight,		
9.87 carats; 11 by 8 by 6 to 8 by 7 by 4.5 mm	No.	1080
HUNGARY.		
Cabochon, rectangular girdle; white with play of colors; 2.645 carats; 10 by 9		
by 5 mm	No.	1078
Czerwenitza:		
Cabochon, elliptical girdle; blue in gray trachyte; 8.245 carats; 20 by 15 by 6 mm	No.	1059
• •	110.	1000
MEXICO.		
Cabochon, elliptical girdle; translucent with internal color; 19.99 carats; 25 by 17 by 10 mm	N.	401
Cabochon, elliptical girdle; red; 13.11 carats; 20 by 14 by 8 mm	No.	401 1050
Cabochon, circular girdle; transparent with internal color; 2.77 carats; 10 by 9 by 8 mm.		
Lot of 80 stones, cabochon, various colors and sizes.		
Hidalgo.		0_0
District Zimapan:		
Five small gems, elliptical, rectangular, and circular girdles; one yellow; four white; total weight, 12.45 carats. Isaac Lea collection	No.	1081
Queretaro.		
Cabochon, pear-shaped girdle; white with internal color; 24.31 carats; 33 by		
20 by 7 mm	No.	1065
Cabochon, elliptical girdle; pink with play of color; 14.95 carats; 25 by 17 by 6 mm		
Cabochon, elliptical girdle; white with play of color; 12.52 carats; 27 by 14	<b></b>	
by 6 mm	No.	1068

Cabochon, elliptical girdle; transparent, slightly cloudy, pale yellow luster; 12.46 carats; 20 by 14 by 8 mm	No.	1069
Cabochon, circular girdle; pale yellow with play of color; 10.96 carats; 20 by 6 mm.		
Table, rectangular girdle; white with play of color; 9.32 carats; 19 by 12 by		
4.5 mm	No.	1068
Three cabochons, two elliptical, one circular girdle; white with internal color; 8.2, 5.74, 5.16 carats; 25 by 11 by 5 mm., 17 by 3 mm., 17 by 14 by		
4.5 mm	No.	1066
Cabochon, elliptical girdle; blue-white with play of colors; 7.445 carats; 20 by 13 by 5 mm	No.	1064
Polished piece, irregularly elliptical; red; 6.57 carats; 20 by 12 by 6 mm	No.	1071
Cabochon, elliptical girdle; white with red and green internal color; 5.96		
carats; 20 by 12 by 4 mm	No.	1063
Cabochon, pear-shaped girdle; white with play of color; 4.85 carats; 19 by 11		-
by 4.5 mm	No.	1065
Five cabochons, four elliptical and one circular girdle; red; 5.73, 5.09, 4.43,		
2.77, and 2.1 carats; 16 by 11 by 5.5, 15.5 by 11 by 6, 13 by 11 by 7, 12 by 9		
by 5, and 9 by 5.5 mm	No.	1067
Two cabochons, oval girdle; blue; 3.66 and 2.93 carats; 18 by 7 by 5 and 14		
by 9 by 5 mm. Gift of W. J. Knowlton	No.	1057
Cabochon, elliptical girdle; transparent, deep yellow luster; 1.99 carats; 14	<b>N</b> 7 -	10=0
by 7 by 4 mm		
Two cabochons, one square, one elliptical girdle; transparent with play of	NO.	1002
color; total weight, 3.19 carats; 8 by 5, 9 by 7 by 6 mm	No	509
Cabochon, elliptical girdle; transparent with play of color; 1.17 carats; 10	110.	002
by 7 by 4 mm.	No.	633
Hacienda Esperanza:		
('abochon, oval girdle; transparent with harlequin colors; 14.535 carats;		
25 by 16 by 7 mm. Isaac Lea collection	No.	1072
Cabochon, oval girdle; yellow with gorgeous play of color; 7.207 carats;		
16 by 12 by 7 mm	No.	1073
Cabochon, elliptical girdle; red with play of colors; 6.88 carats; 15 by		
12.5 by 7 mm	No.	1074
Cabochon, oval girdle; yellow with play of colors; 4.855 carats; 15 by		30=2
11 by 6 mm	No.	1075
4.2 carats; 11 by 9 by 9 mm	No	1076
4.2 Carate, it by 9 by 9 mm.	110.	1010
UNITED STATES.		
Nevada.		
Pendant; black with blue and green internal color; 16.62 carats; 23 by 13		
by 10. Isaac Lea collection.	No.	1084
LOCALITY NOT RECORDED.		
Cabochon, elliptical girdle; smoky with play of colors; 19.28 carats; 28 by 15		
by 7 mm	No.	1085
Oriental Amethyst.—See under Corundum.		
Oriental Emerald.—See under Corundum.		
Oriental Topaz.—See under Corundum.		
Orthoclase.—See under Feldspar, variety Adularia.		

### PEARL.

Calcium carbonate is most widely distributed in a number of forms, the varieties depending upon differences in origin, crystallization and structural condition, presence of impurities, etc. With the exception of pearl and coral, the many forms are used more for decorative purposes than for personal adornment.

Pearls are concretions, or, more correctly, secretions, consisting essentially of calcium carbonate, found in the shells of certain mollusks. They are the result of an abnormal secretory process caused by an irritation of the mantle of the mollusk, resulting from

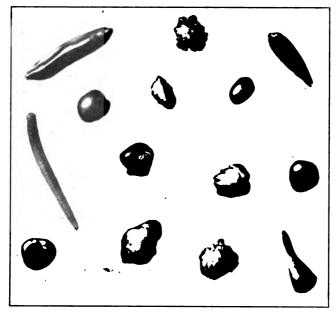


FIG. 8.—BAROQUE PEARLS.

the introduction into the shell of some foreign body, such as a grain of sand.

Pearls possess a luster peculiar to themselves, which is called pearly or nacreous. This luster may exist on the exterior surface only of the concretion, or the outer surface may be dull and dead in luster while an inner surface may be clear and lustrous. Their specific gravity is 2.5 to 2.7; their hardness 2.5 to 3.5. They may be of any shape, and in some instances of considerable size. In color they range from an opaque white, through pink, yellow, purple, red, green, brown, blue, black, in all shades; in addition they may be iridescent. In general, their color and luster will be that of the interior shell surface adjacent to which they are formed.

The beauty and value of pearls is dependent upon their color, texture or "skin," transparency or "water," luster, and form, the

most valuable being those which are round or pear-shaped, slightly transparent, free from specks or blemishes, and possessing to the highest degree the characteristic luster.

Pearls are liable to deteriorate with age, contact with acids, gases, and vapors, and though various methods are in use for restoring them to their original beauty, they are by no means to be relied upon, so that care should be taken to preserve fine pearls by wiping them after use with a clean, soft cloth and keeping them wrapped and in a closed box.

Although nearly all bivalves with nacreous shells occasionally yield pearls, practically all of those of commerce are obtained from only a few families of mollusks, prominent among which are the Aviculidae, Unionidae, and Mytilidae. The pearl oyster of the Pacific and Indian oceans, which has yielded the bulk of the pearls of the world, belongs to the first of these groups. The unio, or freshwater mussel, so abundant in the rivers and lakes of North America, belongs to the second.

The name baroque is given to irregular and sometimes almost grotesquely contorted forms, formerly considered of little value, but now when of good color highly prized. A series of these from freshwater streams in the Mississippi Valley is shown in figure 8.

### LIST OF SPECIMENS.

#### INDIA

INDIA.
Necklace of 148 round pearls; two pear-shaped pearls; white. Gift of the Imam of Muscat
JAPAN (AGO BAY).
Two culture pearls, one white, one pink; 7.5 and 3.9 grains; 7 and 5 mm. diameter. Gift of T. Kume
PANAMA.
One lot of seed pearls. Gift of H. P. Petersen
UNITED STATES.
American fresh waters.
Five turned pearls, white; total weight, 61.7 grains; average size, 10 by 6 mm. Isaac Lea collection
Arkansas.
Black River: Three white pearls, 48, 38, and 34 grains. Isaac Lea collection No. 1842

Two pink pearls, 38.4 and 14.6 grains. Isaac Lea collection...... No. 1841

Indiana,	
Wabash River:	•
One white pearl, 12.5 grains. Isaac Lea collection	No. 1840
Seventeen pearls, various colors and shapes, total weight, 168 grains.	
Gift of B. F. Wheeler	No. 1837
White River:	
One white pearl, 17.8 grains. Isaac Lea collection	No. 1839
Tennessee.	
Holston and Clinch Rivers:	
Thirty-two small pearls, various colors and shapes; total weight, 72	
grains. Isaac Lea collection	No. 1499
LOCALITY NOT RECORDED.	
Bracelet and earrings of small pearls	No. 1496
Fish carved from pearl	
Comb carved from pearl	
Four pearl cat's-eyes, cabochon, circular girdle; gray-brown with pearly	
internal luster; average diameter, 10 mm. Gift of Wirt Tassin	No. 825
Brooch of mother-of-pearl, carved in form of a feather	
Brooch of mother-of-pearl, carved in form of a leaf, with red portion of shell	110. 1001
to represent a bunch of grapes	No 1508
w represent a butten of grapes	110. 1000
Peridot.—See under Chrysolite.	
Perthite.—See under Feldspar.	

### PHENACITE.

Composition.—Beryllium ortho-silicate, Be₂SiO₄.

Crystallization.—Hexagonal (trigonal), rhombohedral.

Color.—Colorless when pure; sometimes colored yellow by traces of impurities.

Luster.—Vitreous; transparent.

Hardness.—7.5; very durable.

Specific gravity.— $2.95 \pm 0.02$ .

Optical properties.—Mean refractive index, 1.66; double refraction moderate, 0.02; optically uniaxial, positive.

The mineral is best identified by its optical properties. It occurs in pegmatites and in veins, and is a rare mineral and not widely used as a precious stone, although it approaches the diamond in brilliance, especially in artificial light. The name, from  $\phi i \nu a \xi$ , deceiver, is said, to have been applied on this account.

### LIST OF SPECIMENS.

### SIBERIA.

Brilliant, rectangular girdle; colorless; 5.22 carats; 12.5 by 11 by 7 mm.	
Isaac Lea collection No. 8	830
Brilliant, square girdle; colorless; 2.14 carats; 8 by 5 mm	831

Plasma.—See under Chalcedony.

Porphyry.—See under Miscellaneous on page 120.

Prase.—See under Chalcedony.

### PREHNITE.

Variety.—Chlorastrolite.

Composition.—Hydrogen calcium aluminum ortho-silicate, H₂Ca₂Al₂(SiO₄)₃.

Crystallization.—Orthorhombic.

Color.—White when pure, but usually pale green, probably owing to the presence of iron. The variety chlorastrolite is mottled green and white.

Luster.—Vitreous; in chlorastrolite somewhat silky; translucent.

Hardness.—6.5; too hard to be scratched readily by a knife; fairly durable.

Specific gravity.—2.90  $\pm$  0.10.

Optical properties.—Mean refractive index, 1.63; double refraction strong, 0.03; optically biaxial, positive.

The mineral is distinguished by its hardness and optical properties from other minerals that resemble it. It is found in veins and cavities in basic igneous rocks, especially basalt and diabase.

Ordinary prehnite is rarely cut as a precious stone, as its color is too pale to be attractive. The variety chlorastrolite, which is mostly obtained from the beaches of Lake Superior, is cut cabochon to bring out the fibrous structure, and is used in scarfpins, etc. It brings but a moderate price, only enough to pay for handling.

LIST OF SPECIMENS.

### UNITED STATES.

### New Jersey.

Hoxie's Quarry, Paterson, Passaic County:	
Cabochon, rectangular girdle; light green; 49.8 carats; 54 by 14 by 8	
mm	61
Two gems, cabochon, circular girdle; light green; 11.98 and 11 carats;	
17 by 6 and 17 by 5 mm	62

### PREHNITE, variety CHLORASTROLITE.

#### Michigan.

Isle Royal, Lake Superior:	
Cabochon, elliptical girdle; dark and light green, mottled; 12 carats; 20	
by 17 by 4 mm. (fig. 2, pl. 7)	No. 364
Cabochon, elliptical girdle; dark and light green, mottled; 5.43 carats;	
12 by 8.5 by 6 mm	No. 363
Four polished stones, irregular; dark and light green, mottled; largest,	
7.7 carats; total weight of three small stones, 3.29 carats; largest 16 by	
11 by 7 mm	No. 366
Three polished stones, two cabochon, one double cabochon; gray-green	
with dark green spots; 6.035, 4.87, and 3.67 carats; 17.5 by 12 by 3, 14	
by 11 by 4, and 13 by 8 by 4.5 mm. Isaac Lea collection	No. 365

### PYRITE.

Synonym.—Sulphur-diamond.

Composition.—Iron disulphide, FeS₂.

Crystallization.—Isometric.

Color.—Brass yellow.

Luster. - Metallic, opaque.

Hardness.—6; can not be cut by a knife; fairly durable.

Specific gravity.— $5 \pm 0.05$ .

Optical properties.—Indeterminate.

Miscellaneous properties.—Some varieties are easily decomposed by moist air, losing their luster and gradually falling to pieces. The color and luster are characteristic.

Pyrite is a very unstable mineral but occurs in a great variety of geological situations. It is used usually without cutting or polishing, as the natural luster is very brilliant. Being a very common mineral it is sold for little more than the cost of trimming and mounting.

LIST OF SPECIMENS.

### UNITED STATES.

### Pennsylvania.

Schuylkill County:

Pyrope.—See under Garnet.

# PYROXENE, variety DIOPSIDE.

Composition.—Calcium magnesium meta-silicate, CaMg(SiO₃)₂.

Crystallization.—Monoclinic.

Color.—Pale green, owing to the presence of a small amount of ferrous iron.

Luster.—Vitreous.

Hardness.-6; not very durable.

Specific gravity.— $3.25 \pm 0.1$ .

Optical properties.—Mean refractive index, 1.71; double refraction strong, 0.03; optically biaxial, positive.

The mineral occurs in metamorphosed limestones. The color, as a rule, is not attractive enough to make it of much importance as a precious stone.

### LIST OF SPECIMENS.

#### CANADA (RENFREW COUNTY, ONTARIO).

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#### UNITED STATES.

### New York.

De Kalb, St. Lawrence County: Cabochon, elliptical girdle; yellow-green; 11.7 carats; 18.5 by 13 by 6 mm Step-brilliant, square girdle; yellow-green; 2.2 carats; 6.5 by 5.5 mm Step-brilliant, rectangular girdle; pale green; 1.9 carats; 8 by 7 by 5 mm Brilliant, rectangular girdle; pale green; 1.56 carats; 7.5 by 6.5 by 5 mm	No. 572 No. 573
LOCALITY NOT RECORDED.	
Step-brilliant, rectangular girdle; yellow-green; 1.18 carats; 10.5 by 5 by 2.5 mm	No. 578

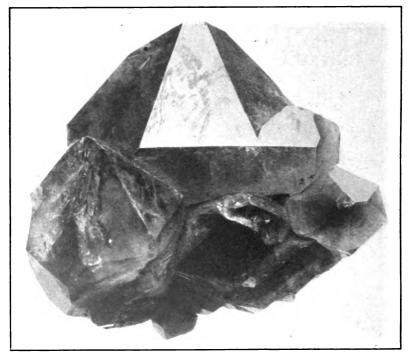


FIG. 9.-LARGE AMETHYSTINE QUARTZ.

# QUARTZ.

Varieties.—Silica, silicon dioxide, occurs in nature under a great variety of forms, which are usually divided into (1) phenocrystalline or vitreous varieties, (2) the cryptocrystalline varieties, and (3) the amorphous or colloidal varieties. Here are included the glassy, sometimes well crystallized forms, known under the names of quartz, rock crystal, amethyst, citrine, and smoky quartz; the massive forms occurring mainly in veins, known as rose, or milky quartz, according to color; and a few others with local or trade names. Under the cryptocrystalline and amorphous varieties are included those which have, to the naked eye, no evidence of having any crystalline

structure, but which are so dense as to appear almost amorphous. (See under Chalcedony and Opal.)

Composition.—Essentially silicon dioxide, SiO₂; some varieties contain admixed iron oxides.

Crystallization.—Hexagonal (trigonal), trapezohedral; crystal habit usually prismatic, with pyramidal terminations (fig. 9); some varieties, such as chalcedony, are only known in the cryptocrystalline condition.

Color.—Colorless when pure, but many of its important varieties are based on colors due to the presence of impurities.

Luster.—Vitreous; in some varieties, waxy; transparent to opaque. Hardness.—7; very durable.

Specific gravity.—2.66 when pure, but varying considerably in impure forms.

Crystallized quartz has a mean refractive index of 1.55 and is optically uniaxial and positive. The chief means of its ready determination are, however, its hardness, which is such that it will scratch glass, its lack of cleavage, and general glasslike appearance and fracture. It is one of the most common of minerals. Small crystals have been produced by artificial means, but never in sizes or colors to rival the natural material. Quartz and the cryptocrystalline varieties of silica are much used in the cheaper grades of jewelry, and it can be scarcely regarded as more than a semiprecious stone, although the better grades of amethyst are very beautiful. The other varieties are worth little more than the cost of cutting. (See further under Chalcedony.)

The chief commercial source of amethyst used in jewelry is the Department of Artigas in northwestern Uruguay and adjacent parts of Brazil. A great deal of the material is exported to Germany, cut, and distributed throughout the world. Cut stones of the material are to be found in all of the leading towns of the United States, and are often sold to the unwary public as a local product. The large botryoidal mass of crystals shown in a special case at the end of the mineral hall is stated to have come from a gigantic geode found in 1900 in the Province of Rio Grande do Sul, Brazil.

LIST OF SPECIMENS.

# QUARTZ.

#### SILESIA.

#### Maine.

Paris, Oxford County:

Virginia.		
Fairfax, Fairfax County:		
Cabochon, elliptical girdle; gray-green, banded; 8.25 carats; 17 by 12		
by 6 mm. Gift of Dr. Robert H. Lamborn		421
Two pieces, tabular, keystone girdle; gray-green, banded; 22.57 and		
19.75 carats; 22 by 17 by 5 and 21 by 16 by 5 mm	No.	1422

# QUARTZ with INCLUSIONS.

# BRAZIL.

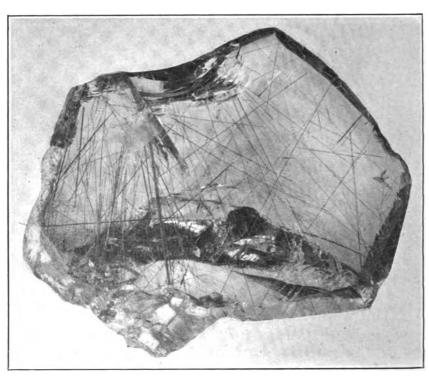


FIG. 10.—QUARTZ CONTAINING RUTILE NEEDLES.

Cabochon, elliptical girdle; colorless with red-brown needles of rutile; 34.73 carats; 34 by 27 by 6 mm	No. 1438
Cabochon, elliptical girdle; colorless with planes of green chlorite; 27.03 carats; 29 by 21 by 7 mm	No. 1440
JAPAN.	
Cabochon, elliptical girdle; colorless with black hornblende needles; 18.65 carats; 24 by 19 by 6 mm. Isaac Lea collection	No. 1442
17.98 carats; 20 by 15 by 9 mm. Isaac Lea collection	No. 1443
SPAIN (NEAR MADRID).	
Cabochon, elliptical girdle; red-brown with indistinct aventurine particles; 22.24 carats; 30 by 21 by 5 mm	No. 1412

#### SWITZERLAND.

Cabochon, elliptical girdle; colorless with rutile needles; 63.95 carats; 38 by 28 by 8 mm
UNION OF SOUTH AFRICA (GRIQUALAND-WEST).
Step-cabochon, rectangular girdle; red-brown, mottled and banded with white; 114.93 carats; 40 by 19 by 12 mm
UNITED STATES.
Arizona.
Clip. Yuma County:  Cabochon, elliptical girdle; dark violet-blue, full of dumortierite;  77.01 carats; 42 by 30 by 7 mm
Arkansas.
Hot Springs, Garland County:  Table, keystone girdle; colorless with red and green chlorite layer;  40.4 carats; 27 by 22 by 9 mm
California.
Elliptical disk; white with inclusions of yellow gold; 27 by 21 by 3 mm No. 1650
Colorado.
Two flat pieces, heart-shaped girdle; colorless with black göthite inclusions; 16.05 and 9.49 carats; 18 by 18 by 8 and 16 by 16 by 5 mm
North Carolina.
Alexander County:  Flat, rectangular girdle; colorless with red-brown rutile needles; 24.12  carats; 24 by 18 by 5 mm
Flat, heart-shaped girdle; colorless with brown-red inclusions of rutile; 15 carats; 19 by 18 by 7 mm. Isaac Lea collection
Rhode Island.
Flat, elliptical girdle; green actinolite in gray; 13.77 carats; 28 by 20 by 3 mm
Virginia.
Fairfax, Fairfax County:  Table-cabochon, rectangular girdle; colorless with dark gray chlorite inclusions; 6.95 carats; 14 by 11 by 5 mm. Gift of Dr. Robert H.  Lamborn

# LOCALITY NOT RECORDED.

Brilliant, circular girdle; pale smoky brown, with rutile needles; 44.615	
carats; 25 by 13.5 carats	No. 1439
carats; 15 by 12 by 7 mm. Isaac Lea collection	N - 1450
Table-cabochon, rectangular girdle; colorless, with pale red rutile needles;	NO. 1400
6.575 carats; 16 by 12 by 4 mm. Isaac Lea collection	No. 1451
QUARTZ, variety AMETHYST.	
BRAZIL.	
Brilliant, elliptical girdle; red-violet; 21.58 carate; 21 by 16 by 11.5 mm	
Brilliant, circular girdle; red-violet; 18.61 carats; 16 by 10 mm	
Brilliant, circular girdle; red-violet; 16.36 carate; 17 by 10 mm	No. 1275
Step-brilliant, elliptical girdle; red-violet, smoky; 10.69 carats; 16 by 15 by	210. 1270
8 mm	No. 1276
Step-brilliant, circular girdle; pale red-violet; 8.025 carats; 13 by 8 mm	
Necklace of 61 beads, separated by rock crystal beads; pale to dark red-violet;	
11 to 5 mm. diameter	No. 1279
Minas Geraes:	
Step-brilliant, elliptical girdle; deep red-violet; 182.57 carats; 48 by 33 by 21 mm. Isaac Lea collection	37 - 1070
· · · · · · · · · · · · · · · · · · ·	NO. 1212
GERMANY (HARZ MOUNTAINS).	
Step-brilliant, irregular elliptical girdle; very pale red-violet; 2.71 carats;	
10 by 9 by 6 mm. Gift of Dr. Henry A. Fischer	No. 1280
JAPAN.	
Step-brilliant, irregular oval girdle; pale red-violet; 24.175 carats; 21 by 19	
by 11 mm	No. 1281
Step-brilliant, irregular triangular girdle; mottled very pale to deep violet;	N. 1007
17.09 carats; 24 by 15 by 9 mm. Isaac Lea collection	140. 1961
mm. Isaac Lea collection	No. 1388
SIBERIA.	
Brilliant, square girdle; deep red-violet; eleven stones, total weight, 3.925	
carats; average size 5 by 3 mm.	No. 1282
UNITED STATES.	
Maine.	
Stow, Oxford County:	
Step-brilliant, circular girdle; deep red-violet; 22.9 carats; 19 by 12 mm.	
Rose, elliptical girdle; red-violet; 13.05 carats; 17 by 14 by 10 mm	No. 1270
North Carolina.	
Amity Hill, Alexander County:	
Double-brilliant, circular girdle; red-violet; 44.5 carats; 24 by 15 mm.	
Isaac Lea collection.	No. 1298
Franklin, Macon County: Step-rose, briolette, heart-shaped girdle; red-violet; 15.32 carats; 17 by	
17 by 11 mm	No. 1297
Step-brilliant, rectangular girdle; deep red-violet; 21.03 carats; 21 by	
16 by 10 mm. Isaac Lea collection	No. 1300
Macon County:	_
Brilliant, elliptical girdle; red-violet; 10.185 carats; 17 by 13 by 8 mm	No. 1285

Statesville, Alexander County:		
Step-brilliant, elliptical girdle; pale red-violet; 202.47 carats; 46 by 34		
by 22 mm. Isaac Lea collection	No.	1286
Double-brilliant, circular girdle; deep red-violet; 122.067 carats; 32 by		
23 mm. Isaac Lea collection	No.	1287
Step-brilliant, circular girdle; red-violet; 33.2 carats; 21 by 14 mm.		
Isaac Lea collection	No.	1288
Step-brilliant, circular girdle; red-violet; 27.48 carats; 20 by 14 mm.		
Isaac Lea collection	No.	1289
Step-brilliant, circular girdle; red-violet; 12.88 carats; 15 by 11 mm.		
Isaac Lea collection	No.	1290
Step-brilliant, circular girdle; pale red-violet; 9.99 carats; 14 by 10		
mm. Isaac Lea collection	No.	1291
Step-brilliant, circular girdle; pale red-violet; 9.95 carats; 14 by 10		
mm. Isaac Lea collection	No.	1292
Step-brilliant, circular girdle; red-violet; 9.32 carats; 14 by 10 mm.		
Isaac Lea collection	No.	1293
Step-brilliant, circular girdle; pale red-violet; 6.55 carats; 12 by 8 mm.		
Isaac Lea collection	No.	1294
Step-brilliant, circular girdle; very pale red-violet; 6.22 carats; 12 by 8		
mm. Isaac Lea collection	No.	1295
Step-brilliant, circular girdle; very pale red-violet; 2.42 carats; 8 by 6		
mm. Isaac Lea collection	No.	1296
Warlick, Burke County:		
Step-brilliant, elliptical girdle; pale red-violet; 14.98 carats; 18 by 16		
by 9 mm. Isaac Lea collection	No.	1284
7) V 11111. 15000 COLOGODO 1111111111111111111111111111111111	_,,,,	1201
Pennsylvania.		
Upper Providence, Delaware County:		
Double brilliant, circular girdle; red-violet; 53.65 carats; 24 by 18 mm.		
Isaac Lea collection	No.	1299
Step-brilliant, octagonal girdle; red-violet; 36.157 carats; 21 by 15 mm.		
Isaac Lea collection	No.	1283
Virginia. Nelson County:		
Brilliant, circular girdle; deep red-violet; 18.7 carats; 17 by 12 mm.		
Isaac Lea collection	Nο	1301
	110.	1001
LOCALITY NOT RECORDED.		
Step-brilliant, elliptical girdle; deep red-violet; 33.47 carats; 25 by 21 by		
10 mm	No.	1302
Step-brilliant, rectangular girdle; pale red-violet; 21.28 carats; 23 by 18 by		
9 mm	No.	1303
Step, rectangular girdle, intaglio; pale red-violet; 15.05 carats; 18 by 16 by		
9 mm	No.	1309
Step-brilliant, elliptical girdle; red-violet; 9.725 carats; 17 by 13 by 9 mm		
Brilliant, elliptical girdle; red-violet; 6.34 carats; 14 by 12 by 8 mm		
Step-brilliant, oval girdle; pale red-violet; 5.9 carats; 16 by 13 by 6 mm.		
Isaac Lea collection	No.	1308
Step-brilliant, elliptical girdle; red-violet; 5.11 carats; 14 by 11 by 6 mm		
Step-brilliant, octagonal girdle; red-violet; 4.66 carats; 11 by 10 by 7 mm	No.	1307
Step-brilliant, elliptical girdle; pale violet and violet; two gems, 17.37 and		•
8.9 carats; 20 by 16 by 9 and 15 by 12 by 8 mm. Bequest, Miss Harriet		
Jekyll	No.	1389
•		

Step-brilliant, elliptical girdle; very pale violet; three gems, 5.38, 3.87, and 2.47 carats; 17 by 12 by 8, 12 by 9 by 6, and 11 by 8 by 5 mm. Bequest, Homer N. Lockwood
Eleven gems, step-brilliant, 10 elliptical, 1 square girdle; deep to very pale violet; total weight, 34.85 carats; 15 by 12 by 7 to 8 by 7 by 5 mm No. 13
Twenty-one gems, step-brilliant and brilliant, various girdles; deep to very pale violet; total weight, 89.55 carats; 18 by 14 by 8 to 7 by 7 by 4 mm.  Isaac Lea collection
QUARTZ, variety CATALINITE.
SANTA CATALINA ISLAND.
Cabochon, elliptical girdle; green, red, and brown, mottled; three stones, 77.1, 37.48, and 16.82 carats; 51 by 28 by 7, 40 by 19 by 6, 34 by 13 by 5 mm
QUARTZ, variety CAT'S-EYE,
BAVARIA.
Two gems, cabochon, circular girdle; gray-green; 2.86 carats; 7 by 4 mm No. 141 Cabochon, elliptical girdle; brown-green; 14.69 carats; 22 by 13 by 7 mm No. 141
CEYLON.
Cabochon, elliptical girdle; pale green; 11.61 carats; 18 by 14 by 7 mm No. 141 Cabochon, elliptical girdle; pale green; 9.06 carats; 15 by 12 by 8 mm No. 141 Four gems, cabochon, elliptical girdle; pale green; 36.78, 11.55, 8.7, and 2.375 carats; 29 by 17 by 10, 20 by 9 hy 9, 14 by 12 by 8, and 10 by 6 by 5 mm. Isaac Lea collection
HUNGARY.
Two gems, cabochon, elliptical girdle; dark gray-green; 5.57 and 2.28 carats; 14 by 10 by 6 and 12 by 8 by 4 mm
INDIA (MADRAS).
String of 22 beads, pale green, 52.68 carats, 10 by 6 to 6 by 4 mm No. 1420 UNITED STATES.
Rhode Island.
Cumberland, Providence County:  Cabochon, elliptical girdle; dark green; 7.57 carats; 19 by 13 by 5 mm. No. 1413  LOCALITY NOT RECORDED.
Cabochon, circular girdle; dark gray-green; 1.71 carats; 9 by 4 mm No. 1421
QUARTZ, variety CITRINE.
AUSTRALIA.
Step-brilliant, elliptical girdle; deep yellow-brown; 169 carats; 45 by 34 by 18 mm
BRAZIL.
Step-brilliant, elliptical girdle; pale yellow; 159.85 carats; 44 by 33 by 20 mm
Step-brilliant, elliptical girdle; yellow-brown; 155.72 carate; 43 by 35 by
18 mm
by 13 mm
Step-brilliant, elliptical girdle; very pale yellow; 54.57 carats; 30 by 23 by 13 mm

Step-brilliant, rectangular girdle; pale yellow; 35 carats; 23 by 20 by	
11 mm	No. 1314
Step-brilliant, elliptical girdle; very pale yellow; 33.3 carats; 27 by 20 by	
	No. 1315
Step-brilliant, elongated octagonal girdle; brown-yellow; 25.18 carats; 24	
by 18 by 9 mm	No. 1318
Step-brilliant, rectangular girdle; pale yellow; 25 carats; 22 by 16 by 11	
mm. Isaac Lea collection	No. 1316
Step-brilliant, elliptical girdle; brown-yellow; 24.25 carats; 24 by 18 by	
10 mm	No. 1317
Step-brilliant, rectangular girdle; pale yellow; 22.18 carats; 20 by 17 by	
10 mm	No. 1319
Step-brilliant, elliptical girdle; pale green-yellow; 14.1 carats; 19 by 14 by	
7 mm	No. 1320
Step-brilliant, elongated octagonal girdle; pale green yellow; 11.92 carats;	
16 by 12 by 9 mm	No. 1321
Step-brilliant, elliptical girdle; pale green-yellow; 9.5 carats; 17 by 13 by	
7 mm.	No. 1323
Step-brilliant, elliptical girdle; pale yellow, cloudy; 9.15 carats; 17 by 13	
by 8 mm	No. 1322
Brilliant, rectangular girdle; very pale yellow, almost colorless; 8.48 carats;	110. 1022
15 by 13 by 8 mm	No. 1324
Step-brilliant, elliptical girdle; pale yellow, cloudy; 7.25 carats; 16 by	110. 1021
11.5 by 7 mm	No. 1227
Brilliant, elliptical girdle; palé green-yellow; 7.185 carats; 15 by 11.5 by	110. 1327
	Nt. 1905
8 mm	
Brilliant, elliptical girdle; pale green-yellow; 6.75 carats; 15 by 11 by 7 mm.	No. 1320
Step, octagonal girdle; pale yellow; 4.51 carats; 12 by 5 mm. Isaac Lea	37. 1000
collection	No. 1329
Step-brilliant, elliptical girdle; very pale yellow; 4.425 carats; 12 by 10 by	
7 mm. Isaac Lea collection	No. 1330
Three gems, step-brilliant, elliptical girdle; yellow-brown; 6.62, 5.25, and	
3.97 carats; 17 by 11 by 6, 14 by 11 by 6, and 12 by 9 by 5.5 mm	No. 1328
ITALY.	
Step-brilliant, elliptical girdle; very pale yellow; 51.14 carats; 29 by 22 by	
12 mm. Isaac Lea collection	No 1929
12 mm. Issac Les conection	110. 1002
SCOTLAND.	
Step-brilliant, octagonal girdle; brown-yellow; 35.2 carats; 22 by 13 mm	No. 1374
Step-brilliant, elliptical girdle; brown-yellow; 8.12 carats; 17 by 13 by 10 mm.	
	110. 10.0
SWITZERLAND.	
Step, rectangular girdle; pale yellow; 91.88 carats; 34 by 27 by 15 mm	No. 1331
UNITED STATES.	
Colorado .	
Florissant, Teller County:	
Step-brilliant, elliptical girdle; pale yellow; 143.32 carats; 40 by 28	
by 20 mm. Isaac Lea collection	No. 456
North Carolina,	
White Plains, Surry County:	•
Brilliant, square girdle; very pale yellow; 136.34 carats; 34 by 23 mm.	
Isaac Lea collection	No. 1333
4555_99 _ Q	

# LOCALITY NOT RECORDED.

Step-brilliant, elliptical girdle; very pale yellow; 99.65 carats; 37 by 30 by	
15 mm. Isaac Lea collection	No. 1372
Step-brilliant, elliptical girdle; yellow; 38.24 carats; 33 by 23 by 12 mm Step-brilliant, elliptical girdle; pale yellow; 34.31 carats; 28 by 21 by 9 mm.	
Step, elongated octagonal girdle; yellow; 33.89 carats; 26 by 17.5 by 11 mm	
Step-brilliant, square girdle; pale yellow; 29.29 carats; 20 by 12 mm	
Step-brilliant, rectangular girdle; yellow; 21.35 carats; 20 by 17 by 9 mm	
Step-brilliant, elliptical girdle; pale yellow; 18.5 carats; 20 by 16 by 9 mm	
Step-brilliant, elliptical girdle; deep yellow; 17.16 carats; 21 by 17 by 10 mm.	
Brilliant, elliptical girdle; deep yellow-brown; 12.81 carats; 18 by 14 by	
9 mm. Isaac Lea collection	No. 1382
7 mm	No. 1367
Step-brilliant, rectangular girdle, intaglio; red-brown; 10.74 carats; 18 by 14	
by 7 mm. Isaac Lea collection	No. 1381
Step-brilliant, elliptical girdle; pale yellow; 6.3 carats; 15 by 11 by 6.5 mm.	
Brilliant, elliptical girdle; pale yellow; 6.17 carate; 14 by 12 by 7 mm	No. 1369
Brilliant, circular girdle; yellow-brown; 1.215 carats; 7 by 5 mm	No. 1384
yellow; 13.32 and 8.37 carats; 18 by 15 by 8 and 17 by 14 by 5 mm. Isaac	
Lea collection	No. 1380
Two gems, step-brilliant, square and elliptical girdles; very pale yellow,	
almost colorless; 4.74 and 2.32 carats; 12 by 5 and 10 by 8 by 5 mm	
Two gems, step-brilliant, elliptical girdle, brilliant, irregular oval girdle;	
pale yellow; 3.5 and 3.45 carats; 13 by 10 by 5 and 12.5 by 11 by 5 mm	No. 1370
Three gems, step-brilliant, elliptical girdle; yellow; 30.135, 19.52, and 12.33 carats; 25 by 18 by 12, 22 by 17 by 8, and 18 by 15 by 7 mm. Isaac Lea	
collection	No. 1376
Five gems, step-brilliant, elliptical girdle; very pale and pale yellow; total	
weight, 18.6 carats; 14 by 9 by 6 to 11 by 9 by 6 mm. Isaac Lea collec-	
tion	No. 1377
Six gems, step-brilliant, pear-shaped girdle; pale yellow; total weight,	Nr. 1999
13.135 carats; 14 by 8 by 5 to 12 by 6 by 4 mm	110. 1363
average size, 14 by 10 by 6 mm. Isaac Lea collection	No. 1378
Eleven gems, brilliant, circular girdle; pale yellow; total weight, 8.12 carats;	
10 by 5 and 8 by 4 mm.; 6 by 4 mm., average size of nine. Isaac Lea col-	
lection	No. 1379
QUARTZ, variety ROCK CRYSTAL.	
BRAZIL.	
Cabochon, circular girdle; colorless; 92.73 carats; 32 by 16 mm	No. 1901
Step-brilliant, rectangular girdle; colorless; 3.21 carats; 13 by 10.5 by 4 mm.	140. 1371
	No. 1392
GERMANY.	
Two lenses, cabochon, circular girdle; colorless, 23.25 and 18.63 carats; 21 by 9 and 19 by 9 mm. Isaac Lea collection	No. 1393
ITALY.	
Step, octagonal girdle; colorless; 10.84 carats; 13 by 10 mm. Isaac Lea col-	
lection	No. 1394

# JAPAN.

JAPAN.	
Two spheres; colorless; 38.11 and 23.86 carats; 18 and 15 mm. diameter.  Isaac Lea collection	No. 1396
Thirteen gems; various cuts; colorless; total weight, 50.88 carats; 17 by 13 by 5.5 to 7 by 7 by 5.5 mm. Isaac Lea collection	
UNITED STATES.	
North Carolina.	
Chestnut Hill Township, Ashe County: Brilliant, circular girdle; colorless; 353.62 carats; 47 by 26 mm. Isaac Lea collection	No. 1397
Brilliant, circular girdle; colorless; 350 carats; 50 by 23 mm. Isaac Lea collection	
Brilliant, circular girdle; colorless; 19.58 carats; 17 by 12 mm. Isaac Lea collection	:
LOCALITY NOT RECORDED.	
Step-brilliant, elliptical girdle; colorless; 47.035 carats; 39 by 21 by 13 mm. Tetrahexahedron; colorless; 32.66 carats; 16 mm. diameter	No. 1409 No. 1401 No. 1403 No. 1402
Step, rectangular girdle; colorless; 15.92 carats; 20 by 18 by 7 mm. Isaac Lea collection	
13.41 carats; 24 by 18 by 4 and 19.5 by 15 by 6 mm	No. 1407
Eight gems, various cuts; colorless; total weight, 33.23 carats; average size, 9 by 5 mm	No. 1405
QUARTZ, variety ROSE.	
BAVARIA (ZWIESEL).	
Step-brilliant, rectangular girdle; very pale pink, opalescent; 16 carats; 20 by 15 by 18.5 mm	No. 1269
Mixed-cabochon, elliptical girdle; pale pink; 13.2 carats; 22 by 13 by 7 mm	
BRAZIL.	
Necklace of 34 spherical beads; pink to pale pink; 15 to 9 mm. diameter CEYLON.	No. 1831
Brilliant, rectangular girdle; pale pink, opalescent; 43.49 carats; 25 by 20 by 15 mm	No. 1267
FRANCE.	_ ,
Brilliant, elliptical girdle; pale pink, opalescent; 18.43 carats; 19 by 15 by 11 mm	No. 1266

#### UNITED STATES.

# Maine.

Paris, Oxford County:		
Cabochon, elliptical girdle; pale pink, opalescent; 66.18 carats; 35 by		
26 by 11 mm	No.	1263
Stoneham, Oxford County: Cabochon, elliptical girdle; pale pink; opalescent; 19.83 carats; 23 by 17 by 7 mm	No.	1264
North Carolina.		
McDowell County:		
Four rose cut beads; very pale pink, opalescent; total weight, 38.4 carats; two 12 mm. diameter, two 10 mm	No.	1265
QUARTZ, variety SMOKY.		
CEYLON.		
Brilliant, elliptical girdle; smoky yellow-brown; 128.1 carats; 39 by 30 by 16		
mm. Isaac Lea collection	No.	1343
Step-brilliant, rectangular girdle; pale smoky yellow; 97.02 carats; 31 by 26	37	
by 18 mm. Isaac Lea collection	No.	1344
Lea collection	No.	1345
Step-brilliant, circular and rectangular girdles; very pale brown; 20.69 and		
6.79 carats; 17 by 11 mm. and 15 by 10 by 6 mm. Isaac Lea collection.	No.	1347
Step-brilliant, rectangular girdle; smoky brown; 6.96 carats; 18 by 13 by 4 mm. Isaac Lea collection	<b>V</b> -	1046
mm. Issac Les conection	NO.	1940
SCOTLAND (ABERDEENSHIRE).		
Two gems, step-brilliant, rectangular girdle; pale smoky brown; 15 and 6.73 carats; 19 by 16 by 7 and 14 by 12 by 6 mm. Isaac Lea collection	No.	1342
SWITZERLAND.		
Step-brilliant, elliptical girdle; pale smoky brown; 268.5 carats; 51 by 40 by		
21 mm	No.	1348
UNITED STATES.		
Arkansas.		
Magnet Cove, Hot Springs County:		
Brilliant, elliptical girdle; deep smoky brown; 80 carats; 36 by 27 by 15 mm	No.	1334
Colorado .		
Florissant, Teller County:		
Brilliant, elliptical girdle; pale smoky brown; 785.20 carate; 73 by 54		1005
by 33 mm. Isaac Lea collection	No.	1330
Brilliant. circular girdle; smoky brown; 163.44 carats; 35 by 27 mm	No.	1336
Maine.		
Mount Mica, Paris, Oxford County:		
Step-brilliant, elliptical girdle; smoky yellow-brown; 17.58 carats; 18 by 15 by 11 mm	No.	1337

Stoneham, Oxford County: Step-brilliant, square girdle; deep smoky brown; 62.977 carats; 27 by 14		1000
mm	No.	1338
North Carolina.		
Mount Pisgah, Alexander County:  Brilliant, elliptical girdle; very pale smoky brown, almost colorless; 543.38 carats; 68 by 51 by 25 mm. Isaac Lea collection	No.	1339
Brilliant, elliptical girdle; pale smoky brown; 284.09 carats; 55 by 42 by 20 mm. Isaac Lea collection	No.	1340
Virginia.		
Fairfax, Fairfax County:  Three gems, brilliant, elliptical and rectangular girdles; smoky brown; 8.16, 5.58, and 2.87 carats; 16 by 13 by 7, 15 by 10 by 6, and 11 by 8 by 5 mm	No.	1341
LOCALITY NOT RECORDED.		
Brilliant, rectangular girdle; smoky brown; 241.73 carats; 49 by 35 by 22 mm. Isaac Lea collection	No.	1351
mm	No.	1353
Lea collection		
mm		
Tetragonal prism; smoky brown; 24.68 carats; 24 by 11 mm		
diameter		
6 mm. Isaac Lea collection		
Lea collectionStep-brilliant, elliptical girdle; pale smoky brown; 4.95 carats; 14 by 11 by		
5 mm. Isaac Lea collection	No.	1359
9.5 by 5 mm		
Rhodolite. See under Garnet.	<b>~.</b>	

# RHODONITE.

Composition.—Manganese metasilicate, MnSiO₃.

Crystallization.—Triclinic.

Color.—Pink, characteristic of manganese compounds.

Luster.—Vitreous; translucent.

Hardness.—6; not very durable.

Specific gravity.— $3.50 \pm 0.10$ .

Optical properties.—Mean refractive index, 1.73; double refraction moderate, 0.01; optically biaxial, negative.

Alters to black manganese oxides in moist air. The mineral is distinguished by its color, rather high specific gravity, and optical properties. It is sometimes cut cabochon and used for scarfpins, buttons, etc., but more often carved into ornaments. Worth little more than the cost of cutting.

#### LIST OF SPECIMENS.

# RUSSIA (URAL MOUNTAINS, EKATERINBURG DISTRICT).

Necklace of 47 beads; rose cut; dull red; 10 mm. diameter	No. 381
Two sleeve buttons, circular; dull red; 35 mm. diameter	No. 383

#### UNITED STATES.

#### California.

Happy Camp, Siskiyou County:

Cabochon, circular girdle; light red and gray; 10.715 carats; 18 by 4 mm.. No. 370

#### Massachusetts.

Cummington, Hampshire County:

#### New Jersey.

Trotter Mine, Franklin, Sussex County:

Rock crystal.—See under Quartz.

Ruby.—See under Corundum.

#### RUTILE.

Variety.—Nigrine.

Composition.—Titanium dioxide, TiO₂; may also contain small amounts of iron, vanadium, chromium, and other metal oxides.

Crystallization.—Tetragonal; habit usually prismatic, and at times acicular (needlelike).

Color.—Usually red, varying to black in the variety nigrine, these colors being largely due to the impurities, especially vanadium oxide; pleochroism distinct.

Luster.—Adamantine to submetallic; transparent to opaque.

Hardness.—6.5; fairly durable.

Specific gravity.—4.20  $\pm$  0.10.

Optical properties.—Mean refractive index 2.75; double refraction extremely high, 0.3; optically uniaxial, positive.

The mineral may as a rule be identified by the high specific gravity, refractive index, and double refraction. Occurs in metamorphic rocks of various kinds and often in acicular crystals penetrating quartz, giving rise to the forms known as sagenitic quartz, Venus's hair stone, fleche d'amour, etc. Rutile is sometimes cut facetted, but the color is too dark and not very attractive, hence it is not widely used as a precious stone. Sagenitic quartz often yields ornamental stones. Rutile is worth little more than the cost of cutting.

#### LIST OF SPECIMENS.

#### UNITED STATES.

## North Carolina.

Hiddenite, Alexander County:

# SAMARSKITE.

Composition.—Complex iron, yttrium, and uranium columbate.

Crystallization.—Orthorhombic.

Color.—Black.

Luster.—Submetallic; practically opaque.

Hardness.—5.5; not durable.

Specific gravity.— $5.70 \pm 0.50$ .

Optical properties.—Indeterminate.

Methods of identification.—Can be recognized more or less definitely by the luster and specific gravity, but can be distinguished from closely related minerals only by analysis.

Occurrence.—Occurs in pegmatite rocks and is sometimes cut brilliant, and is used in place of jet, but is of no greater value than cost of cutting.

LIST OF SPECIMENS.

# UNITED STATES. North Carolina.

Mitchell County:

Sapphire.—See under Corundum.

Sardonyx.—See under Chalcedony.

Satelite. - See under Serpentine.

Satin spar.—See under Gypsum.

Selenite.—See under Gypsum.

#### SERPENTINE.

Varieties.—Williamsite, satelite, precious serpentine, verde-antique.

Composition.—Hydrous magnesium silicate, H₂Mg₃Si₂O₉.

Crystallization.—Probably monoclinic, but never found in good crystals.

Color.—Normally green, owing to a small amount of ferrous iron replacing the magnesium.

Luster.—Vitreous or somewhat greasy; translucent.

Hardness.—4; does not wear well.

Specific gravity.— $2.5 \pm 0.2$ .

Optical properties.—Mean refractive index 1.53; double refraction very weak.

The mineral may be distinguished by its softness, color, and by chemical tests. It occurs as a secondary product in rocks of many kinds, both igneous and metamorphic. It is used mainly as an ornamental stone and is too soft to be of great value as a gem. The variety williamsite is sometimes cut cabochon and used in scarf pins, as are also the fibrous forms. A beautiful variety from the Yu-Yen district of South Manchuria, China, is often carved into various forms and sold to the unwary for jade. According to Dr. J. Morgan Clements it is known locally as Yu Yen Shi (Stone of Yu Yen), or Yu Yen Yue (Jade of Yu Yen).

LIST OF SPECIMENS.

#### SERPENTINE, common.

UNITED STATES. California. San Francisco, San Francisco County: Flower ornament; gray-green; 27 by 20 mm. Gift of Dr. R. E. C. Stearns. No. 371 Massachusetts. Newburyport, Essex County: Necklace of 51 beads; light and dark green; average, 12 mm. diameter. No. 1644 SERPENTINE, variety BOWENITE. Rhode Island. Smithfield, Providence County: Flat cabochon, elliptical girdle; dark olive green; 29.26 carats; 28 by 22 by 7 mm. Gift of George F. Kunz...... No. 373 Cabochon, circular girdle; pale yellow; 3.11 carats; 9.5 by 6 mm. SERPENTINE, variety SATELITE. California. Visalia, Tulare County: Cabochon, rectangular girdle; gray-green with silky luster; 152.35 carats; Cabochon, pear-shaped girdle; gray-green with silky luster; 9.01 carats; SERPEPENTINE, variety WILLIAMSITE.

#### ATTINE, Variety WILLIAMSTIE

# Pennsylvania.

Silicified Wood.—See under Chalcedony.

# SMITHSONITE.

Composition.—Zinc carbonate, ZnCO₃.

Crystallization.—Hexagonal (trigonal), rhombohedral.

Color.—White when pure, but often yellow, green, or blue, owing to the presence of impurities, especially copper carbonates.

Luster.—Vitreous; translucent.

Hardness.—5; not durable.

Specific gravity.—4.40  $\pm$  0.05.

Optical properties.—Mean refractive index, 1.7; double refraction very strong, 0.2; optically uniaxial, negative.

The mineral dissolves with effervescence in hydrochloric acid, as does calcite and several other carbonates, from which it can be distinguished only by reacting for zinc. It is found as a secondary product associated with sulphide zinc ores above the permanent water level. Bright colored specimens are sometimes cut cabochon and used for scarfpins, etc. The value, however, is little greater than the cost of cutting.

LIST OF SPECIMENS.

GREECE (LARIUM).

Cabochon, elliptical girdle; pale green; 79.73 carats; 25 by 22 by 13 mm.... No. 595
UNITED STATES.

Arkansas.

Marion County:

# SODALITE.

Composition.—Sodium aluminum chloro-orthosilicate, Na₄Al₃ Cl(SiO₄)₃.

Crystallization.—Isometric.

Color.—Intense blue.

Luster.—Vitreous; translucent.

Hardness.-5.5; not durable.

Specific gravity.—2.20  $\pm 0.05$ .

Optical properties.—Refractive index, 1.48; optically isotropic.

The mineral may be distinguished from lazurite, the mineral with which it is most likely to be confounded, by failure to evolve hydrogen sulphide when treated with acids. It is occasionally cut cabochon, but not widely used and of no great value. By artificial light nearly black in color.

LIST OF SPECIMENS.

UNITED STATES.

Maine.

Litchfield, Kennebec County:

Cabochon, elliptical girdle; deep blue; 4.44 carats; 14 by 12 by 5 mm.. No. 367

Spessartite.—See under Garnet.

## SPHALERITE.

Synonym.—Zinc-blende.

Composition.—Zinc sulphide, ZnS, with some iron replacing zinc, to which the color is probably due.

Crystillization.—Isometric; tetrahedral; showing prominent dodecahedral cleavage.

Color.—Colorless when pure, but usually pale yellow or brown because of the presence of traces of iron and possibly other elements.

Luster. - Adamantine to resinous; transparent to translucent.

Hardness.—4; too soft to be of much use as a precious stone. Specific gravity.— $4\pm0.10$ .

Optical properties.—Refractive index, 2.37. Isotropic.

The mineral dissolves in hot hydrochloric acid with evolution of hydrogen sulphide. This and its optical properties will usually suffice for its determination. It occurs in veins, beds, and pockets, and is used chiefly as an ore of zinc. Clear material suitable for cutting as a precious stone is exceptional and its use limited.

#### LIST OF SPECIMENS.

#### SPAIN (PICOS DE EUROPA, SANTANDER).

## SPINEL_

Varieties.—Balas ruby or spinel ruby.

Composition.—Magnesium aluminate, MgAl₂O₄, with some iron or other elements replacing magnesium and aluminum.

 $Crystallization. {\bf --Isometric.}$ 

Color.—Usually red, owing to the presence of small amounts of chromium; also colored green by iron or blue by cobalt.

Luster.—Vitreous; transparent.

Hardness.—8; an extremely durable stone.

Specific gravity.— $3.7 \pm 0.2$ .

Optical properties.—Refractive index, 1.72; in ordinary varieties, optically isotropic.

With the microspectroscope red and green varieties show no well-defined absorption bands, but blue varieties show a strong band in the green and one in the blue, characteristic of the metal cobalt. The mineral may be distinguished from true ruby and sapphire by the isotropic character, and from other stones by the properties above listed.

Following the order of the prismatic hues there are red, orange, yellow, green, blue, indigo, and violet colored spinels; and also there are those showing a whole series of intermediate hues, such as pink, heliotrope, lavender, lilac, purple, fawn, corn color, etc. The transparent, lively, red-colored spinel is called *spinel ruby*, and may readily be taken for the true ruby, though its small refractive and dispersive power, together with the absence of pleochroism, render it less brilliant than and lacking the fire of the red corundums. The

rose-red to pink-colored kinds are called balas ruby; the yellow or orange-red spinels are known as rubicelle; the violet and purple ones as almandine; the pale to sapphire-blue kinds as sapphirine; the blacks as pleonast.

Spinel occurs embedded in granular limestone, and with calcite in serpentine, gneiss, and allied rocks; occurring also in cavities in the ejected masses from certain volcanoes. Found also as rolled pebbles in certain alluvials, such as those of Cevlon and Burma, where it occurs in water-worn masses of fine colors in the channels of streams. along with quartz, garnet, tourmaline, sapphire, zircon, and other gem minerals. Spinel ruby is frequently found along with the ruby corundum in the crystalline limestone of the ruby mines of Burma Most of the gem spinel comes from Cevlon, Burma, Siam, India, and other eastern countries. Small crystals of good color are found in the gem-bearing gravel of Expailly, France. The old lavas of Monte Somma, Italy, afford small black crystals of great brilliancy. A pale blue to pearl gray kind is found in the limestone near Aker. Sweden. From Amity, New York, to Andover, New Jersey, a distance of about 30 miles, is a region of granular limestone and serpentine in which localities of spinel abound, the crystals sometimes being fine enough to afford green, black, brown, and, less commonly, red gems. The localities near Franklin, New Jersey, yield crystals of various shades of black, blue, green, and red, which will occasionally afford small gems. While in some demand as a precious stone it is not as generally sought as the ruby varieties of corundum.

#### LIST OF SPECIMENS.

# CEYLON.

Step, rectangular girdle; red-violet; 3.15 carats; 10 by 8 by 5 mm. Isaac Lea collection
Brilliant, square girdle; deep green; 2.40 carats; 9 by 4 mm
Step, rectangular girdle; dark blue-green; 2.1 carats; 9 by 7 by 4 mm.
Isaac Lea collection
Step-brilliant, elliptical girdle; deep red; 1.88 carats; 9 by 8 by 4 mm.
Isaac Lea collection
Brilliant, square girdle; violet; 1.86 carats; 8 by 5 mm
Step-brilliant, elliptical girdle; blue-green; 1.85 carats; 8 by 7 by 5 mm.
Isaac Lea collection
Step-brilliant, rectangular girdle; violet; 1.82 carats; 9 by 7 by 5 mm.
Isaac Lea collection
Step-brilliant, elliptical girdle; bright red; 1.645 carats; 7.5 by 7 by 4 mm.
Isaac Lea collection
Step-brilliant, square girdle; violet-red; 1.48 carats; 7 by 4 mm. Isaac Lea
collection
Step-brilliant, rectangular girdle; yellow-green; 1.466 carats; 7 by 6 by 5 mm.
Isaa c Lea collection
Step-brilliant, circular girdle; dark smoky violet; 1.46 carats; 7.5 by 4 mm.
Isaac Lea collection

Table, equale girdle, doop blue green, 1.00 carate, 1 by 1 mm	,
Step-brilliant, elliptical girdle; violet; 1.178 carats; 7 by 6 by 4 mm No. 597	
Step-brilliant, square girdle; dark violet; 1.036 carats; 6 by 4 mm No. 588	
Cabochon, circular girdle; deep red; 1.01 carats; 6 by 3 mm	,
Step-brilliant, rectangular girdle; dark green; 0.955 carat; 7 by 5.5 by 3.5 mm. No. 615	,
Step-brilliant, circular girdle; red-violet-brown; 0.92 carat; 6 by 3 mm No. 620	)
Table, rectangular girdle; light violet; 0.918 carat; 7 by 5 by 3 mm No. 602	
Step-brilliant, rectangular girdle; orange-red; 0.83 carat; 6 by 5 by 4 mm No. 616	,
Step-brilliant, square girdle; deep rose-red; 0.7 carat; 5 by 3 mm No. 617	
Step-brilliant, elliptical girdle; dark red-violet; 0.635 carat; 6 by 5 by 3 mm. No. 618	,
Brilliant, circular girdle; blue-violet; 0.575 carat; 5 by 3 mm	,
Cabochon, circular girdle; bright red; 0.467 carat; 5 by 3 mm	ŧ
Step-brilliant, square girdle; deep red; 0.435 carat; 5 by 3 mm. Isaac Lea	
collection No. 605	•
EAST INDIES.	
Polished pebble; deep red; 9.1 carats; 13 by 11 by 7 mm	:
Polished pebble; deep red; 5.3 carats; 10 by 8 by 7 mm	,
Polished pebble, pear-shaped; deep red; 4.66 carats; 12 by 8 by 5 mm No. 625	,
Polished pebble; deep red; 4.58 carats; 10 by 9 by 5 mm	
Polished pebble; deep red; 3.79 carats; 10 by 7 by 5 mm	

# SPODUMENE.

Table, rectangular girdle; deep red; 2.815 carats; 8.5 by 7 by 4 mm....... No. 621 

Varieties.—Hiddenite and kunzite.

Composition.—Lithium aluminum metasilicate, Li, Al (SiO₃)₂. The variety hiddenite carries a little chromium, to which it is thought its color may be due.

Crystallization.—Monoclinic; prismatic.

Color.—White to yellow, rarely amethystine. Hiddenite, yellow green to emerald green; kunzite, pale pink.

Luster.—Vitreous, transparent to translucent.

Hardness.—6.5 to 7.

Specific gravity.—3.13 to 3.20.

Optical properties.—Refractive index, 1.66; pleochroism strong.

Hiddenite, or lithia emerald, is a variety of spodumene varying in color from a vellow-green to a deep emerald-green tinged with yellow, the colors of the crystal usually being yellow at one extremity and a more or less deep green at the other. The deeper colored kinds afford a gem resembling the emerald, but having a greater variety of color because of its strong pleochroism. The mineral occurs in slender prismatic crystals one-half inch to 2 inches in length, affording small gems only, the largest being under 3 carats in weight. Hiddenite is at present known from but one locality, Stony Point, Alexander County, North Carolina, where it is found in metamorphic

rocks, generally gneiss or mica schist, in veins of kaolin. The associated minerals are quartz, mica, rutile, beryl, and feldspar.

Kunzite is a pale pink to amethystine variety discovered within the past few years in the pegmatite dikes near Pala, San Diego County, California. It affords very handsome, delicately tinted stones. (See pegmatite collection in the geological hall.)

Most of the gem spodumene other than that mentioned above comes from the province of Minas Geraes, Brazil, where it occurs rather abundantly in crystals closely resembling chrysoberyl in color.

#### LIST OF SPECIMENS.

#### SPODUMENE, common.

#### BRAZIL.

Brilliant, circular girdle; pale yellow; 0.97 carat; 6.5 by 4 mm	No. 252
Brilliant, rectangular girdle; pale yellow; 0.735 carat; 6.5 by 5.5 by 3 mm	No. 253
Brilliant, circular girdle; green-yellow; 0.315 carat; 4.5 by 3 mm	No. 254

# SPODUMENE, variety HIDDENITE.

#### UNITED STATES.

# North Carolina.

Stony Point, Alexander County:	
Brilliant, circular girdle; streaked deep and pale green; 0.7 carat; 6 by	
3.5 mm. Isaac Lea collection	No. 255
Step, rectangular girdle; pale yellow-green; 0.678 carat; 5.5 by 5 by 3.5	
mm	No. 258
Step, rectangular girdle; pale yellow-green; 0.585 carat; 7 by 4 by 3 mm.	No. 260
Step, rectangular girdle; pale green-yellow; 0.535 carat; 5.5 by 5 by 3 mm.	No. 259
Brilliant, square girdle; pale yellow-green; 0.466 carat; 5 by 3 mm	No. 261
Brilliant, rectangular girdle; green; 0.373 carat; 5.5 by 4 by 2.5 mm.  Isaac Lea collection	No. 256
Step, rectangular girdle; green; 0.224 carat; 4 by 3.5 by 2 mm. Isaac	
Lea collection	No. 257

#### SPODUMENE, variety KUNZITE.

# California.

Pala, San Diego County:
Step, elongated octagon girdle; very pale pink; 7.19 carats; 12 by 10 by
8 mm
Step-brilliant, circular girdle; pale pink; 7.137 carats; 12 by 7.5 mm.
Isaac Lea collection

#### STAUROLITE.

Synonyms.—Cross-stone, fairy-stone.

Composition.—Iron aluminum hydroxy silicate, FeAl₅ (OH) (SiO₆)₂.

Crystallization.—Orthorhombic, habit prismatic; frequently twinned in cross or star-like forms.

Color.—Brown, due to the iron present; slightly pleochroic.

Luster.—Vitreous; translucent to opaque.

Hardness. -7 when unaltered, but sometimes less because of decomposition.

Specific gravity.—3.70  $\pm$  0.05.

Optical properties.—Mean refractive index, 1.75; double refraction weak, 0.01; optically biaxial, positive.

The mineral occurs in metamorphic rocks, especially mica schist and is usually recognized from the cruciform character of its crys-

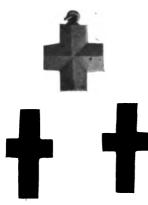


Fig. 11. -- Staurolites or "Fairy stones."

tals. This peculiar cross or star shape of the crystal renders well-developed specimens somewhat prized for ornaments. The crystal faces are usually coated with mica when found, but this can be readily scraped off with a knife and the surfaces can be improved by polishing slightly, and the mineral is usually put on the market in this form. The natural crystals are often ground on the edges to "improve" the cross-like effect. The values are purely nominal.

#### LIST OF SPECIMENS.

#### LOCALITY NOT RECORDED.

# THOMSONITE.

Variety.—Lintonite.

Composition.—Aluminum, calcium, and sodium hydrous silicate.

 ${\it Crystallization.} {\bf -Orthorhombic,\ commonly\ columnar\ radiated.}$ 

Color.—Variable flesh-red, yellow, green, and white.

Luster.—Vitreous, inclined to pearly.

Hardness.-5.5.

Specific gravity.—2.4.

Optical properties.—Doubly refracting, mean refractive index 1.503.

The mineral occurs as a secondary product in radiating and concretionary forms, filling amygdaloidal cavities in basic lavas. On exposure these lavas sometimes break down and the amygdules are liberated, and in the Lake Superior region often accumulate as pebbles in considerable quantities along the beaches, whence they are gathered to be cut for local souvenirs. The value is little more than cost of cutting.

LIST OF SPECIMENS.

UNITED STATES.

#### Minnesota.

Grand Marais, Cook County:

Grand Marais, Cook County-Continued.

Three stones, one cabochon, rectangular girdle: two double cabochon, elliptical girdle; mottled white to red brown, dark green and blue; 27.52, 13.83, and 7.73 carats; 22 by 18 by 9, 19 by 14 by 10, and 16 Four stones, cabochon, elliptical girdle; mottled various colors; 5.97, 5.95, 5.76, and 4.49 carats; 14 by 11 by 6, 15 by 11.5 by 5, 13 by 11 by 7, and 18 by 8 by 5 mm. Isaac Lea collection................. No. 1261

Thulite.—See under Zoisite.

Tiger Eye.—See under Crocidolite.

# TITANITE.

Synonym.—Sphene.

Composition.—Calcium titanium oxy-orthosilicate, Ca(TiO)(SiO₄). Crystallization.—Monoclinic; usually wedge shaped.

Color.—Gray when pure, but usually colored yellow, green, or brown by iron, manganese, or other metals not as yet recognized.

Luster.—Adamantine; transparent.

Hardness. -- 5.5; not very durable.

Specific gravity.— $3.50 \pm 0.05$ .

Optical properties.—Mean refractive index, 1.95; double refraction very strong, 0.15; optically biaxial, positive. Slightly pleochroic.

The high index of refraction renders titanite very brilliant, the play of colors, in fact, approaching that of the diamond. It is best distinguished by the optical properties.

Titanite occurs in metamorphic rocks, both limestone and schist, as well as in veins, from which the best quality stones are obtained. It is usually cut facetted; the inferior hardness renders it somewhat unsatisfactory as a precious stone.

#### LIST OF SPECIMENS.

#### TYROL (ZILLERTHAL).

Brilliant, rectangular girdle; brown-green; 6.177 carats; 12 by 10.5 by 7.5 mm. No. 548 Step-brilliant, rectangular girdle; green-yellow; 2.68 carats; 10 by 7 by 4 mm.. No. 549

# UNITED STATES.

#### New York. Brewster, Putnam County:

Step-brilliant, circular girdle; yellow-brown; 8.5 carats; 13 by 12 by 8 mm . . . . . . No. 550

Brilliant, circular girdle; yellow; 2.55 carats; 9.5 by 5.5 mm. Isaac 

#### Pennsylvania.

# Bridgewater, Delaware County:

Step-brilliant, rectangular girdle; dark green-brown; 4.33 carats; 11 by 8.5 by 6 mm. Gift of Dr. W. H. Forwood....................... No. 552

#### TOPA7

Composition.—Aluminum fluo-orthosilicate, Al₂(F,OH)₂(SiO₄). Crystallization.—Orthorhombic; habit prismatic; cleavage basal. Color.—Colorless when pure, but often showing disperse colors due to constituents of unknown nature; may be pale blue, pale yellow, or pink; pleochroism weak.

Luster.—Vitreous; transparent.

Hardness.—8; a very durable stone.

Specific gravity.— $3.50 \pm 0.05$ .

Optical properties.—Mean refractive index, 1.62; double refraction weak, 0.008; optically biaxial, positive.

The best colorless topazes have considerable fire, and, when properly cut, exhibit brilliant reflections of white light, approximating that of the diamond. The pink topaz is probably not known in



FIG. 12.-TOPAZ CRYSTAL IN MATRIX.

nature, the delicate tint being commonly obtained by heating the yellow or brown colored stones. The process of "pinking" is quite simple. The selected stone is packed in magnesia, asbestos, or lime, and carefully heated to a low red heat, care being taken that the temperature is raised gradually; the stone is then allowed to cool slowly. If the temperature reached has been sufficiently high, the desired pink tint is obtained; if not high enough, a salmon tint; if too high or too long continued, the color is lost completely.

There are several distinct minerals which are commonly called topaz—the topaz proper; the yellow sapphire known as the "oriental topaz;" and certain colored quartzes, known as "Saxon," "Scotch,"

"Spanish," "smoky," and "false topaz." These stones vary rather widely in hardness and specific gravity, which, together with the power of developing frictional electricity possessed by the true topaz, furnishes a ready means for their discrimination. Thus:

Name.	Hardness.	Specific gravity.
Oriental topaz. True topaz. Scotch topaz, etc.	8	4. 01 3. 53 2. 65

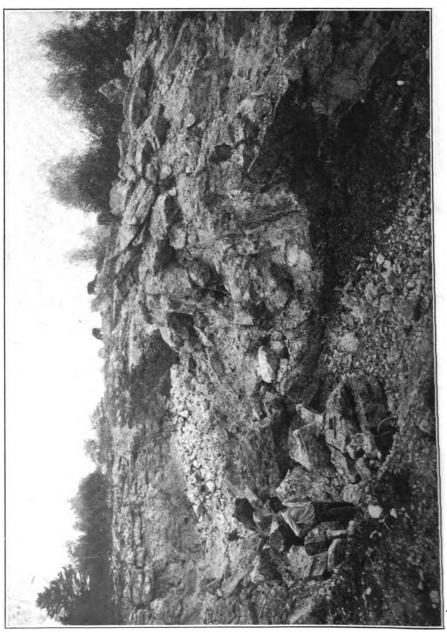
Topaz occurs in gneiss or granite, associated with tourmaline, mica, beryl, etc., and occasionally with apatite, fluorite, and cassiterite; occurs also in certain talcose rocks, in mica slate, in rhyolite, and in alluvial deposits and drift (fig. 12). It is cut facetted and the better grades are highly valued as a precious stone.

#### LIST OF SPECIMENS.

#### BRAZIL (MINAS GERAES).

DRADID (MINAS GERRES).		
Rose, elliptical girdle; pale pink; 14.705 carats; 25 by 17 by 3.5 mm	No.	280
Step-brilliant, rectangular girdle; pale violet-red; 6.54 carats; 13 by 11.5	37	007
by 5 mm	No.	281
Step-brilliant, elliptical girdle; pale yellow; 5.94 carats; 13 by 10 by 5.5		
mm	No.	270
Step-brilliant, elliptical girdle; pale pink; 5.77 carats; 14 by 8 by 6.5 mm.	No.	314
Step-brilliant, elliptical girdle; pale violet-red; 5.65 carats; 14 by 10 by 5 mm	No.	282
Rose, pear-shaped girdle; pale pink; 5.57 carats; 14 by 10 by 6 mm	No.	283
Step-brilliant, elliptical girdle; pale pink; 4.569 carats; 15 by 9 by 4 mm		315
Step-brilliant, irregular elliptical girdle; pale violet-red; 4.035 carats; 11	_,,,	
by 10 by 4 mm	No.	284
Step-brilliant, square girdle; pale yellow; 3.89 carats; 10 by 5.5 mm		271
Step-brilliant, elliptical girdle; pale red-orange; 3.605 carats; 12 by 9 by	210.	
5.5 mm	No	288
Step-brilliant, square girdle; pale pink; 3.398 carats; 10 by 4.5 mm		285
Step-brilliant, elliptical girdle; pale orange-yellow; 3.24 carats; 11 by 8	110.	200
by 5 mm	No	272
Step-brilliant, rectangular girdle; pale violet-red; 3.06 carats; 10 by 8 by	110.	2.2
5 mm	No	287
Step-brilliant, elliptical girdle; pale red-violet; 2.96 carats; 12 by 8 by 4	110.	201
mm	No.	202
Step-brilliant, pear-shaped girdle; pale red-violet; 2.918 carats; 16 by 6.5	110.	202
	No.	286
Step-brilliant, rectangular girdle; pale pink; 2.89 carats; 10 by 8 by 4 mm.		316
Step-brilliant, elliptical girdle; pale pink; 2.85 carats; 10 by 5 by 4 mm.		289
Step-brilliant, rectangular girdle; very pale violet-red; 10 by 8 by 5 mm		297
Step-brilliant, rectangular girdle; pale violet-red; 2.79 carats; 9 by 8 by		201
5 mm	No.	294
Double-rose, elliptical girdle; pale violet-red; 2.7 carats; 7 by 6 by 6 mm	No.	303
Step-brilliant, pear-shaped girdle; very pale red-violet; 2.59 carats; 15 by		
6 by 4 mm	No.	293
4555—22——9		

Step-brilliant, elliptical girdle; pale violet-red; 2.59 carats; 11 by 7 by 4		-
	No.	. 30
Step-brilliant, elliptical girdle; pale violet-red; 2.43 carats; 10 by 7.5 by	MT-	90
4.5 mm	No.	. 29
mm	No	90
Step-brilliant, elliptical girdle; pale violet-red; 2.28 carats; 10 by 7.5 by	110.	. 20
4 mm	No.	29
Step-brilliant; rectangular girdle; pale orange; 2.255 carats; 8 by 6.5 by 5		
mm	No.	31
Step-brilliant, square girdle; yellow; 2.255 carats; 9 by 4 mm		
Step-brilliant, elliptical girdle; pale orange-red; 2.2 carats; 11.5 by 7 by		
4 mm	No.	29
Step-brilliant, rectangular girdle; pale orange-red; 2.15 carats; 9 by 7.5 by		
4 mm	No.	29
Step, irregular rectangular girdle; pale orange-yellow; 2.07 carats; 11 by		
6 by 3.5 mm		
Step, rectangular girdle; pale violet-red; 1.99 carats; 11 by 5.5 by 4 mm		
Step, rectangular girdle; pale violet-red; 1.92 carats; 10 by 8 by 2.5 mm	No.	29
Step-brilliant, rectangular girdle; pale violet-red; 1.87 carats; 9 by 8 by		
3 mm		
Step, rectangular girdle; pale yellow; 1.8 carats; 10 by 6 by 3 mm		
Brilliant, square girdle; pale violet-red; 1.77 carats; 7 by 5 mm		
Step-brilliant, square girdle; pale orange-red; 1.74 carats; 7 by 4 mm		
Step-brilliant, circular girdle; deep yellow; 1.7 carats; 7.5 by 4.5 mm Step-brilliant, rectangular girdle; pale violet-red; 1.67 carats; 8.5 by 7 by 4	MO.	211
mm	No.	20.4
Step-brilliant, pear-shaped girdle; pale yellow; 1.66 carats; 9 by 8 by 4 mm.		
Step-brilliant, elliptical girdle; pale violet-red; 1.528 carats; 9 by 6 by 4 mm.		
Step-brilliant, rectangular girdle; pale violet-red; 1.48 carats; 8 by 6.5 by 4	210.	
mm	No.	306
Step-brilliant, elliptical girdle; pale violet-red; 1.467 carats; 8.5 by 6 by 4		
mm	No.	309
Step-brilliant, rectangular girdle; pale yellow; 1.375 carats; 8 by 5 by 4 mm.		
Step-brilliant, rectangular girdle; pale violet-red; 1.309 carats; 7 by 5.5 by		
4 mm	No.	312
Step-brilliant, elliptical girdle; pale violet-red; 1.28 carats; 10 by 5 by 3 mm	No.	310
Step-brilliant, elliptical girdle; pale violet-red; 1.078 carats; 9 by 5.5 by 3		
ınm		
Step-brilliant, rectangular girdle; pink; 1.01 carats; 7.5 by 5 by 3 mm		
Rose, elliptical girdle; pale yellow; 0.93 carat; 7 by 5 by 4 mm	No.	279
JAPAN.		
Th'll' + ' 1 - ' 11 1 1 1 2020 + 251 105		
Brilliant, circular girdle; colorless; 18.12 carats; 15 by 10.5 mm	No.	1178
Takayama:	37-	occ
Brilliant, circular girdle; colorless; 50.787 carats; 22 by 16.5 mm	No.	200
RUSSIA.		
Alabashku, Ekaterinburg District.		
Step, rectangular girdle; pale blue; 155.46 carats; 31 by 28 by 20 mm	No.	262
Siberia.		
Step-brilliant, elliptical girdle; pale blue; 7.27 carats; 13 by 9 by 7.5 mm	No.	266



#### Ural Mountains.

Step, rectangular girdle; colorless; 12.816 carats; 19 by 11 by 7 mm	No.	263 264 265
SCOTLAND.		
Step, square girdle; pale blue; 3.525 carats; 10 by 5 mm. Isaac Lea collection	No.	269
UNITED STATES.		
Colorado.		
Brilliant, rectangular girdle; colorless; 17.77 carats; 17 by 12 by 10 mm Step-brilliant, rectangular girdle; red-brown; 14.626 carats; 19 by 14 by 6 mm.	No.	319
Isaac Lea collection	No.	318
Maine.		
Stoneham, Oxford County: Brilliant, square girdle; colorless; 2.875 carats; 9 by 6 mm	No.	324
New Hampshire.		
Baldface Mountain, Chatham, Carroll County: Brilliant, circular girdle; colorless; 12.357 carats; 15 by 9 mm	No.	323
Utah.		
30 miles southwest of Salt Lake City, Salt Lake County: Brilliant, circular girdle; colorless; 1.46 carats; 7 by 5 mm Brilliant, circular girdle; colorless; 1.369 carats; 7 by 5 mm Brilliant, circular girdle; colorless; 0.89 carat; 5.5 by 4 mm. Isaac Lea collection	No.	320 321
,		

# TOURMALINE.

Varieties.—Achroite, colorless; indicolite, blue; rubellite, pink.

Composition.—A complicated boro-silicate of magnesium, iron, aluminum, and alkali metals.

Crystallization.—Hexagonal (trigonal), hemimorphic; habit usually prismatic with strong vertical striation and different terminal faces at the opposite ends of the crystal.

Color.—Colorless when containing but traces of iron, but usually colored intensely blue, green, brown, pink, to dense black, etc., by iron, manganese, chromium, or possibly other elements; strongly pleochroic.

Luster.—Vitreous; transparent to translucent and opaque.

Hardness.—7; a durable stone.

Specific gravity.—Varying considerably with composition, but averaging 3.1.

Optical properties.—Mean refractive index varying with the composition, but usually about 1.65; double refraction moderately strong, 0.02; optically uniaxial, negative.

The matter of color is of interest. Some specimens are of one color only; others are green at one extremity and red at the other; some are green, then yellow, red, and finally green; others are crimson, tipped with black, or dark green passing into blue. A crystal may be white at the termination, then green of varying shades, pink and colorless, and in cross section dark blue or red at the center, surrounded by concentric layers of white, pink, and green. Another specimen may be red internally, passing into a lighter hue and finally green, or it may be blue or black internally, then red, and then green externally. In some specimens the different colors pass imperceptibly into one another; in others the line of demarcation is well defined.

The optical structure of the tourmaline is unique. When a crystal is viewed along the direction of its vertical axis it is less transparent and of different color than when viewed across that axis. For instance, a crystal viewed through the side is a transparent green, but when viewed through the end of the prism it may be either opaque or yellow green.

The marked pleochroism of the colored tourmalines influences to a great degree the appearance of the fashioned stone. For example, if a green-colored specimen is cut so that the table is parallel with the vertical axis of the crystal, the gem will exhibit a play and interchange of colors of two shades of green; if, however, the specimen is so cut that the table of the fashioned stone is perpendicular to the vertical axis, the gem will appear more or less opaque and dark colored, and will exhibit its transparency and green coloring only when viewed across the girdle. Care should be taken, therefore, in fashioning the tourmaline that the table is parallel with the vertical axis of the crystal; further, the facets of the crown should be large and well developed in order to exhibit to the utmost the differences of color for light transmitted in different directions as the gem is viewed from different positions.

The geological occurrence of the four types of tourmaline is of interest. The lithia group—which is often beautifully colored and affords the best gem material—is associated with soda and potash feld-spar in pegmatite veins along with lepidolite and muscovite. The iron and the magnesia-iron groups, which are commonly black or brownish black, occur in granites, gneisses, schists, and also to a certain extent in pegmatites along with the lithia group. The magnesia group—commonly brown in color—occurs chiefly in crystalline magnesian limestones associated with mica, pyroxene, scapolite, etc.

In the United States magnificent colored tourmalines have been found in Maine at Auburn, Hebron, Norway, Andover, Rumford, Standish, and Paris. (See pl. 10.) The famous locality at Mount Mica, near Paris, was discovered in 1820, and for many years yielded fine specimens of green and parti-colored tourmalines. Some crystals

were over an inch in diameter, transparent ruby red within, surrounded by green, or red at one extremity and green at the other. One blue crystal found was 9 inches long. The locality affords all of the colored varieties, achroite, indicolite, and rubellite. Red and green tourmalines are found at Chesterfield, Massachusetts, in a granite vein with albite, uraninite, and pyrochlore, the crystals small and curved, nearly opaque, and fragile; green crystals, often with distinct prisms of red color inside, are found at this locality. At Goshen, Massachusetts, similar varieties occur, and the blue is met with in great perfection. At Haddam, Connecticut, in crystals in mica-slate with anthophyllite, also in granite with iolite, and also at the gneiss quarries, on the east side of the river. At Haddam Neck, in fine green, and parti-colored crystals affording magnificent gems. Near Gouverneur, New York, light and dark brown crystals, often highly modified. Good crystals are found in Chester County, Pennsylvania.

The most noted American locality for the pink and variegated tourmaline is the Mesa Grande region in San Diego County, southern California. The mineral occurs here also in pegmatitic rocks associated with the variety of spodumene commercially known as kunzite, and occasional gem minerals of other varieties. A very complete and systematic series of these pegmatites from both the Appalachian regions and California, with their associated minerals, is to be found among the rock collections in the geological hall on the first floor of the Museum. (See also pp. 136–139.)

In Canada magnificent green-yellow crystals occur in the limestone at Great Calumet Island; amber-colored ones at Fitzroy, Ontario; transparent brown at Hunterstown, Quebec; black at Bathurst and Elmsley, Ontario, and St. Jerome, Quebec. Small brilliant crystals of the black variety are found in decomposed feldspar, at Andreasberg in the Hartz. Rubellite and green tourmaline occur near Ekaterinburg in Russia. The Island of Elba yields pink, red, white, green, black, and parti-colored crystals. Brazil affords a large proportion of the specimens used for gems, and has been one of the great sources of supply for more than 200 years. Ceylon, India, and Burma produce good gem material, the latter locality affording some magnificent rubellites, rivaling the ruby in color.

#### LIST OF SPECIMENS.

#### BRAZIL.

Cabochon, triangular girdle; red and green; 59.99 carats; 28 by 10 mm	No.	225
Step-brilliant, elliptical girdle; blue-green; 36.78 carats; 24 by 21 by 12		
mm	No.	1118
Brilliant, rectangular girdle; green-yellow; 9.19 carats; 15 by 13 by 8 mm		
Step, rectangular girdle; deep green; 8.59 carats; 14.5 by 13 by 6 mm	No.	1115

Brilliant, rectangular girdle; pale violet-red; 5.192 carats; 11.5 by 9 by 7.5	<b>N</b> T -	001
mm	NO.	
Brilliant, elliptical girdle; violet-red; 5.155 carats; 14 by 9.5 by 6 mm	No.	226
Step-brilliant, elliptical girdle; deep blue-green; 4.912 carats; 14.5 by 11 by 4 mm	<b>N</b> T -	000
	140.	220
Step-brilliant, rectangular girdle; dull green-brown; 3.827 carats; 10 by		
9 by 6 mm	No.	1116
Step-brilliant, rectangular girdle; deep blue-green; 2.79 carats; 10 by 8 by		
4.5 mm	No.	223
Step-brilliant, square girdle; deep blue-green; 2.378 carats; 9 by 5 mm		222
Step-brilliant, elliptical girdle; pale yellow; 2.276 carats; 8 by 7.5 by 6 mm.		:117
Step, rectangular girdle; dark green; 1.725 carats; 15 by 3.5 by 3 mm		230
Step-brilliant, rectangular girdle; dark green; 1.5 carats; 9 by 7.5 by 3 mm.		224
Step, rectangular girdle; yellow-green; 1.4 carats; 9 by 6 by 3 mm		227
Step, rectangular girdle; yellow-green; 1.36 carats; 9 by 6 by 3 mm		228
Step, rectangular girdle; dark green; 1.285 carats; 14 by 4 by 3 mm		231
Step, rectangular girdle; dark green; 1.13 carats; 7.5 by 6.5 by 3 mm		229
Step, rectangular girdle; dark green; 0.885 carats; 14 by 3 by 2.5 mm	No.	232
Step, rectangular girdle; dark green; 0.76 carat; 12 by 3 by 2 mm		233
Step-brilliant; rectangular girdle; violet-red; 0.515 carat; 5 by 4 by 3.5		
mm	No	235
Step-brilliant, square girdle; dark blue; 0.425 carat; 5 by 2.5 mm	M-	234
Brilliant, circular girdle; light green; 0.425 carat; 4.5 by 3.5 mm	No.	236
CEYLON.		
Cabochon, elliptical girdle; pale green; 12.53 carats; 15 by 12 by 6.5 mm.		
Isaac Lea collection	No.	237
Step-brilliant, elliptical girdle; brown; 3.14 carats; 10 by 9 by 6 mm. Isaac		
Les collection	Nο	238
Step-brilliant, square girdle; brown; 2.749 carats; 9 by 5 mm. Isaac Lea	110.	200
	37	~~~
collection	NO.	239
Step-brilliant, elliptical girdle; brown-yellow; 2.66 carats; 8.5 by 6 by 5		
mm. Isaac Lea collection	No.	241
Step-brilliant, rectangular girdle; brown; 1.9 carats; 7.5 by 7 by 5 mm.		
Isaac Les collection	No.	240
Step-brilliant, rectangular girdle; red-brown; 1.06 carats; 8 by 6 by 4 mm.		
Isaac Lea collection	No.	242
Step-brilliant, elliptical girdle; orange-yellow; 0.829 carat; 6 by 5 by 5 mm.		
Isaac Lea collection.	Nο	243
Three gems, step-brilliant, elliptical girdle; pale orange-yellow; total weight,	110.	210
1.454 carats; average size, 4 by 3 by 2 mm. Isaac Lea collection	N.	044
1.404 Caraus, average size, 4 by 5 by 2 mm. Issaec Lea Collection	140.	<i>2</i> 17
ISLAND OF ELBA.		
Step-brilliant, rectangular girdle; pale red and yellow-green; 9.844 carats;		
16.5 by 9.5 by 8 mm.	No.	251
SIBERIA.		
Step-brilliant, elliptical girdle; pale red-violet; 2.5 carats; 9 by 7.5 by 6 mm	Ma	947
	740.	<i>6</i> 11
Step-brilliant, elliptical girdle; pale red-violet; 2.445 carats; 9 by 7 by 6	•	
mm		
Step-brilliant, circular girdle; red-violet; 1.598 carats; 7 by 6 mm		
Step-brilliant, square girdle; red; 0.557 carat; 5 by 3.5 mm	No.	250

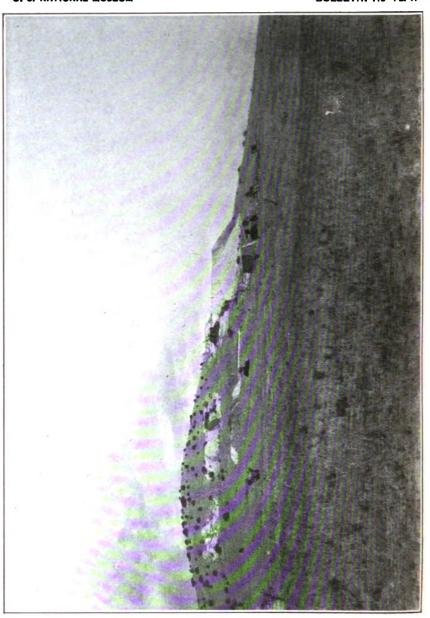
# UNITED STATES.

# California.

Step-brilliant, circular girdle; violet-red; 3.75 carats; 9.5 by 7 mm. (Ru-	
bellite)	No. 1175
Brilliant, circular girdle; yellow-green; 2.73 carats; 9 by 6 mm	No. 1176
Mesa Grande, San Diego County:	
Cabochon, elliptical girdle; violet-red; 76.65 carats; 33 by 25 by 13	
mm. Isaac Lea collection	No. 1790
Cabochon, elliptical girdle; violet-red; 19.115 carats; 21 by 14 by 8	
mm. Isaac Lea collection	No. 1792
Cabochon, elliptical girdle; violet-red; 12.68 carats; 17 by 13 by 8	
mm. Isaac Lea collection	No. 1791
Trap, octagon girdle; violet-red; 10.75 carats; 14 by 12 by 7 mm. Isaac	
Lea collection	No. 1172
Trap, octagon girdle; pale brown-yellow; 5.79 carats; 11 by 10 by 7 mm.	
Isaac Lea collection	No. 1173
Cabochon, elliptical girdle; violet-red; 5.48 carats; 12 by 9 by 6 mm.	
Isaac Lea collection	No. 1793
Brilliant, elliptical girdle; violet-red; 4.54 carats; 12 by 10 by 6 mm.	
Isaac Lea collection	No. 1780
Trap, octagon girdle; pale orange-red; 3.96 carats; 10 by 9.5 by 6 mm.	
Isaac Lea collection	No. 1174
Cabochon, circular girdle; violet-red; 3.84 carats; 10 by 5 mm. Isaac	
Lea collection	No. 1794
Brilliant, elliptical girdle; very pale violet-red; 2.69 carats; 9 by 8 by 5	
mm. Isaac Lea collection	No. 1781
Brilliant, circular girdle; violet-red; 2.525 carats; 9 by 5 mm. Isaac	
Lea collection	No. 1782
Brilliant, elliptical girdle; yellow-green; 2.35 carats; 9.5 by 7 by 5 mm.	
Isaac Lea collection	No. 1783
Brilliant, circular girdle; pale violet-red; 2.29 carats; 8.5 by 5 mm.	
Isaac Lea collection	No. 1784
Cabochon, elliptical girdle; pale violet-red; 2.25 carats; 10 by 7 by 4.5	
mm. Isaac Lea collection	No. 1795
Brilliant, elliptical girdle; pale yellow-green; 1.92 carats; 9 by 7 by 5	
mm. Isaac Lea collection	No. 1785
Brilliant, elliptical girdle; pale orange-yellow; 1.76 carats; 9 by 7 by 4.5	
mm. Isaac Lea collection	No. 1786
Brilliant, elliptical girdle; very pale blue, almost colorless; 1.68 carats;	
9 by 7 by 4 mm. Isaac Lea collection	No. 1787
Brilliant, elliptical girdle; violet-red; 1.6 carats; 9 by 7 by 4 mm.	
Isaac Lea collection	No. 1788
Two stones, cabochon, circular girdle; violet-red; 1.6 and 1.5 carats; 7	
by 4 and 6.5 by 4 mm. Isaac Lea collection	No. 1796
Brilliant, circular girdle; violet-red; 0.95 carats; 7 by 4 mm. Isaac	
Lea collection	No. 1789
Cross section, triangular; violet-red edge, yellow-green interior with	
opalescent colors; 32 by 33 by 7 mm. Isaac Lea collection	No. 1797
Six cross sections; violet-red and yellow; 15 by 13 by 6 to 9 by 8 by 3	
mm. Issac Lea collection	No. 1798
Thirty-one crystals; violet-red and green, various sizes	

# Connecticut.

Rock Landing, Middlesex County:	
Brilliant, circular girdle; blue-green; 0.995 carat; 6.5 by 5 mm	No. 1111
Brilliant, circular girdle; blue-green; 0.857 carat; 6.5 by 4 mm	
Brilliant, circular girdle; blue-green; 0.772 carat; 6 by 4 mm	No. 1113
Maine.	
Auburn, Androscoggin County:	
Step-brilliant, rectangular girdle; pale violet-blue; 2.779 carats; 12 by	
6.5 by 5 mm	
Step-brilliant, rectangular girdle; pale blue-green; 1.797 carats; 8 by 7	
by 4 mm	
Brilliant, rectangular girdle; blue-green; 1.737 carats; 8 by 6 by 5 mm.	
Step, rectangular girdle; deep green; 1.625 carats; 7 by 6 by 5 mm	
Brilliant, rectangular girdle; colorless; 1.54 carats; 8 by 7 by 5 mm	
Step-brilliant, square girdle; blue-greer; 1.35 carats; 6.5 by 5 mm	
Step-brilliant, rectangular girdle; very pale green; 1.22 carats; 7 by 5	
by 5 mm	
Step-brilliant, rectangular girdle; very pale blue-green; 1.12 carats; 6.5	NO. 1120
by 5.5 by 5 mm	No. 1120
mm	No. 1127
Paris. Oxford County:	NO. 1120
Brilliant, square girdle; deep green; 58.459 carats; 23 by 17 mm. Isaac	
Lea collection	No. 1100
Lea collection	
Brilliant, circular girdle; orange-brown; 16.72 carats; 17 by 11 mm.	
Isaac Lea collection	
Step-brilliant, rectangular girdle; parti-colored, pale red and pale	
green; 11.967 carate; 19 by 11 by 7 mm	
Brilliant, circular girdle; white, smoky; 8.79 carats; 13 by 10 mm.	1101 1101
Isaac Lea collection	
Step, square girdle; pale green; 7.936 carats; 12 by 8 mm	No. 1135
Step, rectangular girdle; pale green; 7.68 carats; 16 by 10 by 6 mm	No. 1145
Brilliant, circular girdle; blue-green; 5.549 carats; 12 by 6 mm	
Step, rectangular girdle; blue-green; 4.9 carats; 11 by 9 by 6 mm	
Brilliant, rectangular girdle; violet-red; 4.47 carats; 12 by 10 by 6 mm.	
Brilliant, circular girdle; very dark blue; 4.41 carats; 11.5 by 6.5 mm	
Step, rectangular girdle; pale blue-green; 4.16 carats; 11 by 9 by 6 mm.	
Step, square girdle; violet-red; 4.117 carats; 10 by 6 mm	
Step-brilliant, rectangular girdle; parti-colored, green, colorless; 3.4	
carats; 13 by 9 by 4.5 mm. Isaac Lea collection	No. 1129
Step, rectangular girdle; pale green; 3.367 carats; 10.5 by 8 by 5 mm	
Step, rectangular girdle; pale green; 3.088 carats; 11 by 7 by 5 mm	
Step, square girdle; deep violet-red; 2.73 carats; 9.5 by 4 mm	
Step, rectangular girdle; pale green; 2.428 carats; 10.5 by 7 by 4.5 mm.	
Step, square girdle; very pale pink; 2.286 carats; 9 by 4 mm	
Step, square girdle; parti-colored, pale red, very pale red, orange; 2.277	
carats; 9 by 8.5 by 4 mm. Isaac Lea collection	No. 1130
Brilliant, square girdle; pale pink; 2.08 carats; 8 by 6 mm	
Step-brilliant, rectangular girdle; pale violet-red; 1.497 carats; 8.5 by	
6.5 by 4 mm	
•	



Paris, Oxford County—Continued.		
Brilliant, square girdle; pale violet-blue; 1.23 carats; 6 by 5 mm		
Brilliant, circular girdle pale pink; 1.104 carats; 6.5 by 4 mm	No.	1159
5.5 by 5 mm	No.	1143
Step-brilliant, rectangular girdle; colorless; 1.06 carats; 8 by 5.5 by 3		
mm		
Step, rectangular girdle; deep blue; 1.014 carate; 8 by 6 by 3 mm		
Step, square girdle; deep green; 0.952 carat; 6 by 3 mm		
Step-brilliant, rectangular girdle; colorless; 0.839 carat; 8 by 5 by 3 mm.		
Step-brilliant, triangular girdle; green-yellow; 0.745 carat; 5 by 3.5 mm.		
Step-brilliant, rectangular girdle; colorless; 0.726 carat; 7 by 5 by 3 mm.		
Brilliant, circular girdle; deep green-blue; 0.672 carat; 6 by 4 mm		
Step, square girdle; deep green; 0.657 carat; 5.5 by 3 mm		
Step, rectangular girdle; deep blue; 0.65 carat; 6.5 by 5 by 2.5 mm		
Step-brilliant, rectangular girdle; very pale pink, almost colorless; 0.636		
carat; 6.5 by 4.5 by 3 mm	No.	1166
Brilliant, rectangular girdle; pale green; 0.627 carat; 5.5 by 5 by 4 mm.	No.	1154
Step, rectangular girdle; deep green; 0.607 carat; 6 by 5 by 3 mm	No.	1155
Step-brilliant, elliptical girdle; yellow-green; 0.555 carat; 6 by 5 by 3		
mm	No. 1	L167
Brilliant, rectangular girdle; black, opaque; 0.55 carat; 6 by 4 by 3 mm.	No 3	1144
Brilliant, circular girdle; pale yellow-green; 0.54 carat; 5 by 4 mm.		
Isaac Lea collection		
Brilliant, circular girdle; pale green; 0.5333 carat; 6 by 3.5 mm	No. 1	l168
Step, square girdle; deep green; 0.515 carat; 5 by 3 mm	No. 1	1157
Step, rectangular girdle; pale green; 0.5 carat; 6 by 4 by 2.5 mm		
Brilliant, circular girdle; colorless; 0.41 carat; 4.5 by 4 mm		
Step, rectangular girdle; pale blue-green; 0.388 carat; 7 by 3 by 2 mm.	No.	1171
New York.		
De Kalb, St. Lawrence County: Step-brilliant, rectangular girdle; pale yellow; 5.68 carats; 11.5 by 8 by		
6 mm	No 1	106
Macomb, Essex County:	110. 1	100
Two gems, brilliant, circular girdle; brown; 1.21 and 0.87 carats; 7 by		
5 mm. and 6 by 4 mm	No. 1	1107
LOCALITY NOT RECORDED.		
Trap, rectangular girdle; dull violet-red; 2.72 carats; 10 by 8 by 4 mm	No. 1	1177
TURQUOISE.		
Composition.—Copper aluminum hydrous phosphate, CuAl _e (19H ₂ O.	PO,	4+
Crystallization.—Triclinic; distinct crystals rare, the mineral	ıl he	ino
almost always crypto-crystalline.	50	••••ō
Color.—Blue, owing to the copper present.		
Luster.—Vitreous; translucent to opaque.		
Hardness.—6; not very durable.		
nuruness.—o; not very durable.		

Because of its crypto-crystalline character, turquoise will absorb grease and oils readily, and it is not, therefore, absolutely satisfactory

Specific gravity.— $2.70 \pm 0.10$ .

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as a precious stone, particularly when worn as a necklace and next to the skin. Its opaque nature and robin's-egg blue color are its most pronounced characteristics, but it can be determined absolutely only by chemical tests. The only natural stone with which it is likely to become confused is variscite, likewise an aluminum phosphate. From this last it can, as a rule, be distinguished by its blue cast, variscite being green, inclined to yellowish. The mineral occurs



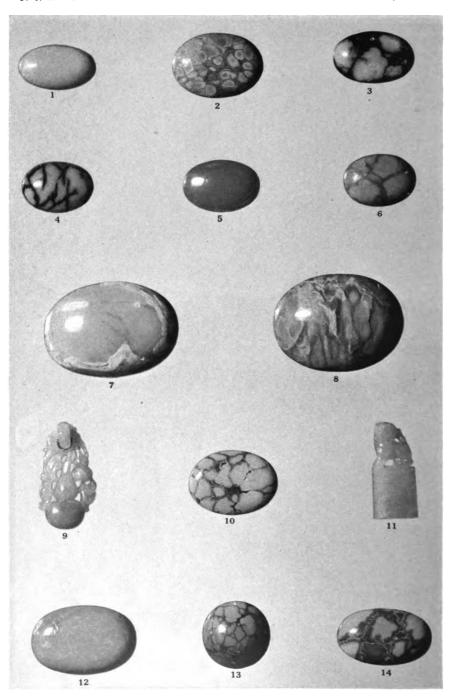
Fig. 13.—Chinese carving in turquoise.

as a secondary product in veins and pockets in aluminous rocks, both igneous and sedimentary. It is easily and abundantly imitated artificially, and on this and other accounts the so-called "matrix" turquoise—that is, stones including portions of the matrix—are most desirable. Turquoise is usually cut cabochon because of its opaque nature, and has been for centuries much admired as a gem, both by civilized and barbarous people. In the United States it is found only in Arizona, Nevada, and New Mexico.

# LIST OF SPECIMENS.

## CHINA.

Carving, representing man and dragon; blue-green; 71.075 carats; 34 by 33 mm. (fig. 13)	No.	1093
FRANCE.		
Five fossil bone turquoise, cabochon, elliptical girdle; three green-blue, two blue-green; total weight, 5.8 carats; 17 by 11 by 3 to 9 by 7 by 2 mm	No.	591
PERSIA.		
Two stones, cabochon, circular girdle; blue with brown matrix; 13.67 and 12.55 carats; 19 by 5.5 and 18 by 6 mm. Isaac Lea collection (fig. 13, pl. 12).	No.	1812
UNITED STATES.		
Arizona.		
Mineral Park, Mohave County:		
Rectangular fragment polished; veinlet of blue in light brown matrix; 9.045 carats; 15 by 12 by 5 mm. Isaac Lea collection	No.	1097
5.99 carats: 15 by 4 mm	No.	1088
Nevada.		
Belmont, Nye County:		
Cabochon, elliptical girdle; blue in dark brown matrix; 9.315 carats; 24 by 10 by 6 mm	No.	1098
Polished piece; dark and light blue and green in brown matrix; 14.465		
carats; 25 by 15 by 5 mm. Isaac Lea collection (fig. 14, pl. 12)	No.	1096
Tabular, keystone girdle; mottled pale and dark blue with white matrix;		
10.93 carats; 19 by 21 by 3 mm	No.	1092
Cabochon, elliptical girdle; pale blue with brown and green matrix; 10.89 carats; 23 by 17 by 4 mm. (fig. 10, pl. 12)	No	1000
Cabochon, elliptical girdle; blue with matrix of green and brown; 9.6	110.	1000
carats; 30 by 10 by 4 mm	No.	1091
Cabochon, elliptical girdle; dark and light blue and brown matrix;		
5.39 carats; 14 by 10 by 6 mm	No.	1089



VARISCITE, TURQUOISE, CHRYSOPRASE, AND JADE FOR DESCRIPTION OF PLATE. SEE PAGE VIII

#### New Mexico.

Cerrillos, Santa Fe County:		
Cabochon, elliptical girdle; blue-green; 26.90 carats; 28 by 18 by 7 mm.		
(fig. 12, pl. 12)	No.	650
Cabochon, elliptical girdle; blue-green; 18.54 carats; 23 by 18 by 6 mm.		
Gift of Dr. Robert H. Lamborn	No.	652
Cabochon, elliptical girdle; pale blue-green; 13.99 carats; 24 by 16 by		
6 mm. Gift of Dr. Robert Lamborn	No.	653
Cabochon, circular girdle; green-blue; 9.355 carats; 14 by 7 mm. Gift		
of American Turquoise Company	No.	655
Cabochon, elliptical girdle; green-blue; 7.69 carats; 16 by 10 by 6 mm.		
Gift of American Turquoise Company	No.	657
Cabochon, elliptical girdle; green-blue; 5.38 carats; 14 by 9 by 6 mm.		
Gift of American Turquoise Company	No.	658
Cabochon, circular girdle; green: 4.95 carats; 16.5 by 3 mm. Gift of		
American Turquoise Company	No.	659
Cabochon, elliptical girdle; green-blue; 4.7 carats; 20 by 9 by 4 mm.		
Gift of American Turquoise Company	No.	<b>6</b> 56
Cabochon, elliptical girdle; green-blue; 4.16 carats; 12 by 10 by 5.5 mm.		
Gift of American Turquoise Company	No.	660
Cabochon, elliptical girdle; blue-green; 3.79 carats; 16 by 8 by 4 mm.		
Gift of American Turquoise Company	No.	661
Nine matrix stones, eight elliptical, one circular girdle; one pale blue;		
eight blue-green; total weight, 55.48 carats; 20 by 13 by 6 to 11 by		
5 by 3.5 mm. Gift of H. P. Petersen		
Carved arrowhead mounted as a scarfpin; blue-green; 22 by 9 mm	No.	654
LOCALITY NOT RECORDED.		
Carving in imitation of a frog; green-blue; 0.635 carat; 6 by 5 by 3 mm.		
Gift of O. T. Jonassohn	No.	1087
Unakite.—See under Miscellaneous (Granite) on page 120.		

# VARISCITE.

Synonym.—Utahlite.

Composition.—Hydrous aluminum phosphate, Al(PO₄) +2H₂O.

Crystallization.—Orthorhombic; distinct crystals rare, the material being usually crypto-crystalline.

Color.—Green to blue-green, owing to the presence of chromium or vanadium, or both.

Luster.—Vitreous; translucent to opaque.

Hardness.—4; not a durable stone under ordinary conditions of wear.

Specific gravity.— $2.40 \pm 0.05$ .

Optical properties.—Mean refractive index, 1.55; double refraction moderate, 0.02; optically biaxial.

The mineral may be distinguished from turquois, which it sometimes closely resembles, by its more greenish color and less hardness, and from other gems which resemble it, by chemical tests. It occurs filling fissures and cavities in rocks high in aluminum, mostly in shale or slate (pl. 13). In use it is usually cut cabochon because of its practically opaque character. Of less value than turquoise.

#### LIST OF SPECIMENS.

#### UNITED STATES.

#### Nevada.

Cabochon, circular girdle; green and black, mottled; 31.425 carats; 18 by 7	
mm. Gift of Pacific Gem Company	No. 1100
Candelaria, Esmeralda County:	
Table; elliptical girdle; bright green with dark spots; 5.24 carats; 21	
by 10 by 3 mm. Gift of Mack Weber	No. 1099
· Utah.	
Lucin, Boxelder County:	
Seventy-one stones, cabochon, elliptical and pear-shaped girdles; show-	
ing variation from pale green to deep green, mottled with gray and	
black; 25.19 to 1.6 carats; 29 by 20 by 7 to 9 by 7 by 4 mm. (figs. 1-3,	
4, 6, pl. 12)	No. 1104
Six stones, cabochon, elliptical girdles; green mottled with gray and	
white; 113.15 to 56.42 carats; 45 by 35 by 12 to 35 by 25 by 10 mm.	
(figs. 7, 8, pl. 12)	No. 1101
\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	

# VESUVIANITE.

Variety.—Californite.

Composition.—A complex silicate.

Crystallization.—Tetragonal; habit prismatic to columnar.

Color.—May be yellow, brown, or yellow-green, depending on the state of oxidation of the iron present; pleochroism faint.

Luster.—Vitreous; translucent.

Hardness.—6.5; a fairly durable stone.

Specific gravity.—3.40  $\pm$  0.10.

Optical properties.—Mean refractive index, 1.72; double refraction weak, 0.006; optically uniaxial, negative.

Vesuvianite in general is distinguished by its optical properties; californite, a deep green variety, resembles some forms of serpentine and jade; from the former it is distinguished by its much greater hardness, from the latter by the fact that it is softer, more crystalline, and has a distinctly higher index of refraction. It occurs in metamorphic rocks, chiefly in limestone. Is rarely cut as a precious stone, but the variety californite is sometimes carved or cut into slabs for ornamental purposes.

#### LIST OF SPECIMENS.

# LOCALITY NOT RECORDED.

# VESUVIANITE, variety CALIFORNITE.

UNITED STATES.

California.

Happy Camp, Siskiyou County:

# WERNERITE.

Synonym.—Scapolite.

Composition.—A complex calcium aluminum sodium chloro-silicate.

Crystallization.—Tetragonal; pyramidal; habit prismatic.

Color.—White when pure; may be colored pale violet or pale yellow by impurities of unknown composition.

Luster.—Vitreous.

Hardness.—5.5; not very durable.

Specific gravity.—2.70  $\pm$  0.10.

Optical properties.—Mean refractive index 1.55; double refraction moderate, 0.01. Optically uniaxial, negative.

The mineral is distinguished by color and optical properties. Occurs chiefly in metamorphosed limestone. Because of its peculiar color it is occasionally cut cabochon, but is worth little more than the cost of cutting.

# LIST OF SPECIMENS.

# CANADA (TEMPLETON, QUEBEC).

#### MADAGASCAR.

#### Tsarasaotra Province.

Brilliant, square girdle; pale yellow; 8.2 carats; 12 by 9 mm. Isaac Lea	
collection No. 1	818
Step-brilliant; elongated octagonal girdle; pale yellow; 5.77 carats; 12 by	
10 by 7 mm. Isaac Lea collection	819

#### WILLEMITE.

Composition.—Zinc orthosilicate, Zn₂(SiO₄), with some manganese replacing the zinc.

Crystallization.—Hexagonal (trigonal), tri-rhombohedral.

Color.—Colorless when pure, but usually pale green-yellow.

Luster.—Vitreous; translucent.

Hardness.—5.5; not very durable.

Specific gravity.  $-4.10 \pm 0.10$ .

Optical properties.—Mean refractive index, 1.70; double refraction moderate, 0.02; optically uniaxial, positive.

The high specific gravity of the mineral is a rather characteristic feature, and in color and general appearance it differs from practically every other precious stone. The only willemite thus far found suitable for cutting occurs in the zinc-ore deposit at Franklin Furnace, New Jersey. Most of the material is opaque, or only translucent, and is used as an ore of zinc; but occasional specimens are found which are clear and yield small stones, which are usually cut brilliant.

4555-22-10

#### LIST OF SPECIMENS.

#### UNITED STATES.

# New Jersey.

Franklin Furnace, Sussex County:		
Brilliant, circular girdle; deep yellow; 11.045 carats; 12 by 11 mm.		
Gift of Clarence S. Bement	No.	1086
Three small gems, brilliant, circular girdle; pale green-yellow; total		
weight, 0.79 carat; 5 by 3 and 3 by 2 mm	No.	547

#### ZIRCON.

Variety.—Hyacinth.

Composition.—Zirconium orthosilicate, Zr(SiO₄).

Crystallization.—Tetragonal, habit prismatic.

Color.—Colorless when pure, but usually showing disperse colors, especially pale green, yellow, or brown, owing to iron and perhaps other constituents; rarely blue.

Luster.—Adamantine; transparent.

Hardness.—7.5; a very durable stone.

. Specific gravity.—Averaging about 4.7.

Optical properties.—Mean refractive index 1.95; double refraction strong, 0.06; optically uniaxial, positive.

Some varieties of zircon yield with the microspectroscope a brilliant and characteristic absorption spectrum, due to the presence of small amounts of uranium in the lower state of oxidation. This spectrum consists of eight narrow bands, the strongest of which lies in the orange, the others being somewhat uniformly distributed through the whole spectrum. Specimens free from uranium, however, show no spectrum whatever, so that this is not a certain test for the mineral. The high specific gravity and refractive index are sufficiently characteristic for identification. In this last respect, indeed, the zircon resembles diamond in luster and play of colors, or "fire." It is cut facetted and rather widely used as a precious stone, although its colors are, as a rule, not particularly attractive.

# LIST OF SPECIMENS.

#### AUSTRALIA.

# Queensland.

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Policeman Knob:	
Brilliant, circular girdle; pale green-blue; 2.55 carats; 7.5 by 5 mm.	
Isaac Lea collection	9
Brilliant, circular girdle; pale green-blue; 2.55 carats; 7.5 by 5 mm.	
Isaac Lea collection	7
Brilliant, circular girdle; pale green-blue; 2 carats; 7 by 5 mm. Isaac	
Lea collection	8
Brilliant, circular girdle; pale green-blue; 1.59 carats; 6.5 by 4 mm.	
Isaac Lea collection	0
Brilliant, circular girdle; pale green-blue; 1.49 carats; 6 by 5 mm.	
Isaac Lea collection	9
Brilliant, circular girdle; pale green-blue; 0.96 carat; 5 by 4 mm.	
Issac Lea collection No. 181	1

#### CEYLON.

Step-brilliant, rectangular girdle; dull green-brown; 21.22 carats; 18 by 17		
by 7 mm	No.	325
Rose, elliptical girdle; pale green-brown; 6.866 carats; 15 by 10 by 5.5 mm.		
Isaac Lea collection		449
Step-brilliant, elliptical girdle; brown-yellow; 5.09 carats; 9 by 8 by 7 mm.		337
Rose, circular girdle; green-brown; 4.98 carats; 12 by 4 mm		333
Rose, circular girdle; pale green-yellow; 4.85 carats; 11 by 5 mm	No.	334
Rose, circular girdle; pale green-yellow; 4.614 carats; 11 by 4 mm	No.	335
Step-brilliant, rectangular girdle; yellow-brown; 4.377 carats; 11 by 8 by 5.5 mm	No	330
Rose, circular girdle; pale green-yellow; 4.335 carats; 11 by 4 mm		336
Brilliant, square girdle; pale smoky brown; 4.31 carats; 10 by 6 mm		328
Step-brilliant, rectangular girdle; yellow-green; 3.777 carats; 10 by 8 by		-
7 mm		331
Step-brilliant, elliptical girdle; brown; 3.24 carats; 8.5 by 8 by 5.5 mm Step-brilliant, elliptical girdle; brown-green; 3.058 carats; 11 by 7.5 by		339
5 mm	No.	338
Brilliant, elliptical girdle; pale blue; 2.406 carats; 9 by 7 by 5 mm. Gift		
of Clarence S. Bement	No.	329
Brilliant, elliptical girdle; smoky red-brown; 2.335 carats; 11 by 7.5 by 3		
mm		340
Rose, elliptical girdle; nearly colorless; 1.94 carats; 8 by 7 by 5 mm		342
Rose, oval girdle; nearly colorless; 1.926 carats; 9 by 6.5 by 4 mm	No.	341
Step-brilliant, rectangular girdle; brown-green; 1.88 carats; 9 by 7.5 by 5		
	No.	<b>32</b> 6
Step-brilliant, rectangular girdle; pale green-blue; 1.46 carats; 7 by 6 by		
4 mm	No.	345
Step-brilliant, rectangular girdle; pale green-blue; 1.436 carats; 7 by 5.5 by		
4 mm	No.	346
Step-brilliant, elliptical girdle; brown-yellow; 1.415 carats; 7 by 6 by 3		
mm	-	332
Brilliant, elliptical girdle; yellow-green; 1.38 carats; 7.5 by 7 by 4 mm		344
Brilliant, elliptical girdle; violet-brown; 1.32 carats; 9 by 5.5 by 3 mm		347
Brilliant, rectangular girdle; green-yellow; 1.27 carats; 6.5 by 5 by 4 mm		348
Brilliant, rectangular girdle; orange-yellow; 1.2 carats; 7 by 6 by 4 mm		349
Step-brilliant, circular girdle; red-brown; 1.12 carats; 7 by 4.5 mm		350
Brilliant, square girdle; dull yellow-green; 1 carat; 7 by 5 mm		327
Step-brilliant, square girdle; pale yellow; 0.98 carat; 6 by 5 by 3 mm		351
Step, elliptical girdle; green-yellow; 0.707 carat; 7 by 4 by 2 mm	No.	352
Ninety-one small gems, rose, circular girdle; blue and pale yellow; total weight, 17.94 carats; 5 by 3 to 3 by 2 mm	. No.	353
Ninety-eight very small gems, brilliant, circular girdle; colorless; total		
weight, 3.325 carats; Isaac Lea collection	No.	450
LOCALITY NOT RECORDED.		
Brilliant, elliptical girdle; brown; 51.29 carats; 25 by 19 by 12 mm. Isaac	No 1	1170

# ZOISITE: THULITE.

This is a massive form of a calcium aluminum silicate which is gray when pure, but often colored pink or red by traces of manganese. It is hard and quite durable and occurs in metamorphic rocks

like mica schists. Being compact and opaque, it is cut only cabochon or carved into small ornaments.

#### LIST OF SPECIMENS.

#### NORWAY.

Cabochon, elliptical girdle; violet-red; 44.25 carats; 22 by 19 by 13 mm.... No. 582 Cabochon, elliptical girdle; violet-red; 8.465 carats; 17 by 13 by 5 mm..... No. 583

#### MISCELLANEOUS.

# GRANITE.

# NORWAY (HITTERÖ).

# Virginia (Milan's Gap, Madison County).

#### HUNTILITE.

# CANADA (SILVER ISLET, LAKE SUPERIOR).

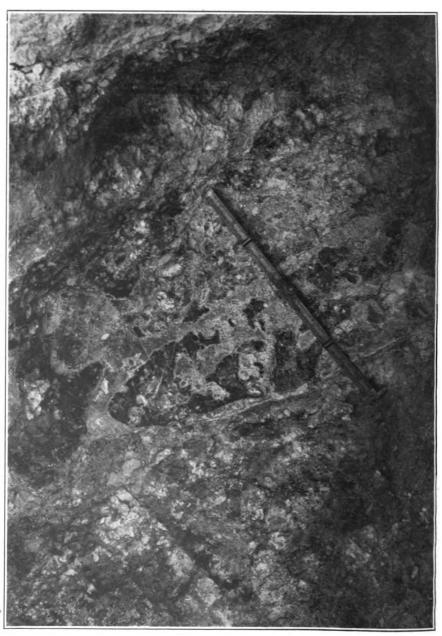
Two rectangular disks; 16.66 and 14.46 carats; 20 by 15 by 4 mm......... No. 379

# PORPHYRY.

# SWEDEN.

#### UNITED STATES.

# North Carolina (Charlotte, Mecklenberg County)



# 4. SUPPLEMENTAL COLLECTIONS.

#### 1. ROUGH AND CUT STONES.

It was Dr. Leander T. Chamberlain's expressed desire that the Lea collection should consist, for the most part, of cut stones. For educational purposes, however, it seemed desirable to show in many cases the rough materials as well, since there is often a marked difference in appearance of the material in the two conditions. A

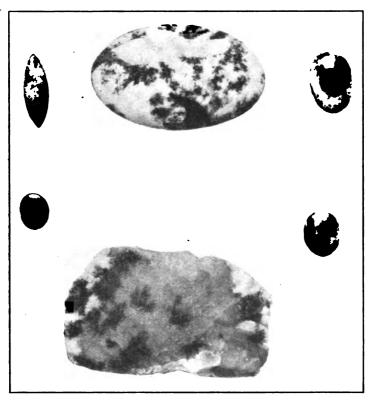


FIG. 14.-MOSS AGATES IN BOUGH AND CUT FORMS.

supplemental collection has, therefore, been established, duplicating the first in part. As at present installed this is limited to a single case, comprising the minerals listed below, the rough material and the stones cut from it being placed side by side, usually on the same block or pad.

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BENITOITE, San Benito County, California. Brilliant, circular girdle; blue; two gems, total weight, 1.24 carats; 6 by 4 and 4 by 3 mm. Cut from
specimen 86539
BERYL, San Diego County, California. Brilliant, circular girdle; very pale
pink; 4.315 carats; 11 by 7 mm
BERYL (AQUAMARINE), Sekinotsu, Omi, Japan. Brilliant, circular gir-
dle; very pale blue-green; 5.695 carats; 11 by 9 mm. Cut from crystal 61774
CALAMINE, Ysabelita, Mexico. Cabochon, elliptical girdle; blue and
white; two gems, 9.43 and 7.89 carats; 15 by 12 by 6.5 and 17 by 10 by 6 mm. Cut from specimen 87466
CALCITE (SATIN SPAR), Cumberland, England. Cabochon, elliptical
girdle; white, satin luster; 31.97 carats; 33 by 19 by 7 mm. Cut from
specimen 81675
CHALCEDONY, Mohave Desert, California. Five gems, cabochon, four
elliptical, one circular girdles; very pale opalescent; total weight, 17.12
carats; 18 by 7 by 5 to 11 by 8 by 4 mm. Cut from specimen 87415 No. 1527
CHALCEDONY, 35 miles east of Johannesburg, California. Twenty-two
gems, cabochon, various girdles; cloudy blue; total weight, 103.035
carats: 22 by 13 by 5 to 11 by 8 by 4 mm. Cut from specimen 87407 No. 1528
CHALCEDONY in JASPER, Death Valley, California. Twelve gems,
cabochon, elliptical girdle; mottled gray and red; total weight, 45.615
carats; 15 by 12 by 5 to 11 by 9 by 4 mm. Cut from specimen 87401 No. 1532
CHALCEDONY, Amelia, Virginia. Seven gems, cabochon, various girdles;
yellow mottled with red and brown; total weight, 21.635 carats; 15 by 7
to 12 by 7 mm. Cut from specimen 87412
CHALCEDONY, Ellensburg, Washington. Cabochon, elliptical girdle;
cloudy blue; 6.85 carats; 20 by 10 by 6 mm. Cut from specimen 87414 No. 1526
CHALCEDONY (JASPER), Death Valley, California. Twenty gems, cabo-
chon, various girdles; mottled red, green, and brown; total weight, 145
carats; 31 by 13 by 8 to 10 by 5 mm. Cut from specimen 87405 No. 1533
CHALCEDONY (JASPER var. KINRADITE), San Francisco, California.
Twelve gems, cabochon, elliptical and circular girdles; mottled red, gray,
and green; total weight, 47.6 carats; 21 by 9 by 5 to 8 by 4 mm. Cut from
specimen 87422
CHALCEDONY (JASPER var. KINRADITE), San Francisco, California.
Cabochon, elliptical girdle; red and light brown; 13.7 carate; 25 by 14 by
6mm . Cut from specimen 87422
CHALCEDONY (MOSS AGATE), Glendive, Montana. One cabochon,
elliptical girdle, two table, elliptical and square girdles; gray with dark
brown inclusions; 35.67, 25.43, and 15.69 carats; 53 by 32 by 3, 23 by 4,
32 by 20 by 4 mm. Cut from specimen 87400
CHALCEDONY (MOSS AGATE), Fremont County, Wyoming. Two gems,
cabochon, elliptical girdle; cloudy with black inclusions; 26.04 and 11.69
carats; 24 by 16 by 10 and 19 by 14 by 7 mm
CHALCEDONY (MOSS AGATE), Guernsey County, Wyoming. Two
stones, white with black inclusions; total weight, 58.73 carats; 48 by 30 by
7 mm., 10 by 7 by 2 mm. Cut from specimen 8740 (fig. 14)
CHALCEDONY (MYRICKITE), near Johannesburg, California. Nine
stones, one cabochon, eight elliptical girdles; mottled red-brown and
white; total weight, 34.5 carats; 15 by 12 by 5.5 to 9 by 7 by 4 mm. Cut
from specimen 87411
-

CHALCEDONY (SILICIFIED WOOD), Adamana, Arizona. Cabochon,		
elliptical girdle; mottled red, brown, and yellow; 64.25 carats; 42 by 28 by		
8 mm. Cut from specimen 34059	No. 1	548
CHALCEDONY (SILICIFIED WOOD), Adamana, Arizona. Twelve stones,		
cabochon, ten elliptical, two circular girdles; total weight, 41.55 carats;		
yellow, brown, red, mottled; 23 by 7 by 4 to 9 by 4 mm. Cut from speci-		
men 87406	No. 1	537
CHLORASTROLITE, Grand Marais, Cook County, Minnesota. Cabochon,		
three elliptical, one rectangular girdle; mottled green and black; total		
weight, 19.57 carats; 18 by 11.5 by 5 to 10 by 8.5 by 3 mm. Cut from		
specimens 93426	No. 1	262
CHRYSOLITE, Navajo Indian Reservation, Arizona. Two gems, brilliant,		
circular and elliptical girdles; yellow-green; 1.78 and 1.43 carats; 8 by 5		
and 9 by 6 by 4 mm. Gift of Frank Springer	No. 1	571
CROCIDOLITE, Griqualand, South Africe. Pair of cuff buttons, circular		
girdle; brown; 19 mm. diameter; with specimens 92892	No. 1	546
EPIDOTE. Canon City, Colorado. Six stones, cabochon, elliptical and cir-		•
cular girdles; yellow-brown; total weight, 27.67 carats; 19 by 8 by 5 to 10		
by 5 mm. Cut from specimens 87417	No. 1	556
FELDSPAR (AMAZONSTONE), Florissant, Colorado. Eighteen stones,		
cabochon, various girdles; blue-green; total weight, 61.7 carats; 21 by 15		
by 4.5 to 8 by 4 mm. Cut from specimen 87418	No. 1	554
FELDSPAR (AMAZONSTONE), Amelia Courthouse, Virginia. Three		
stones, cabochon, elliptical girdle; green; 42.30, 36.67, and 31.38 carats;		
36 by 24 by 7, 39 by 21.5 by 6, and 35.5 by 22 by 5.5 mm. Cut from speci-		
men 49164	No. 1	259
FOSSIL CORAL, Alpena, Michigan. Cabochon, elliptical girdle; 134.87		
carats; 45 by 38 by 9 mm. Polished specimen of 37475	No. 1	551
GARNET (ALMANDITE), Navajo Indian Reservation, Arizona. Bril-		
liant, circular girdle; deep red; two gems, 2.12 and 1.12 carats; 8.5 by 5 and		
7 by 4 mm. Gift of Frank Springer	No. 1	570
GYPSUM (SATINSPAR), Sicily. Two stones, cabochon, elliptical girdle;		
white, with satin luster; 22.6 and 20 carats; 25 by 17 by 9 and 25 by 17 by 7		
mm. Cut from specimen 82367	No. 1	573
LABRADORITE, Modoc County, California. Six gems, cabochon, ellipti-		
cal girdle, and brilliant, circular girdle; pale yellow to red-brown; total		
weight, 8.2 carats; 13 by 7 by 3 to 7 by 5 mm. Cut from specimen 87269	No. 1	567
LAPIS-LAZULI, Chile, South America. Cabochon, elliptical girdle; mot-		
tled blue; 16.96 carats; 22 by 16 by 6 mm. Cut from specimen 62802	No. 1	260
OBSIDIAN, Glass Buttes, Oregon. Cabochon, elliptical girdle; dark and		
light brown, banded; 71.9 carats; 43 by 31 by 9 mm. Cut from specimen		
35268	No. 1	552
QUARTZ (AMETHYST), Warren County, North Carolina. Two gems,		
brilliant, elliptical and circular girdles; deep red-violet; 9.47 and 4.49		
carats; 17 by 14 by 7 and 11 by 7 mm. Cut from specimen 87184	No. 1	522
QUARTZ (BRECCIATED CHERT), New Mexico. Cabochon, elliptical		
girdle; gray, 20.95 carats; 32 by 12 by 8 mm. Cut from specimen 87467	No. 1	545
QUARTZ (CATALINITE), Santa Catalina Island. Six stones, cabochon, 5		
elliptical, one pendant; green, red, and brown, mottled; total weight, 69.5		
carats; 31 by 13 by 7 to 12.5 by 10 by 4.5 mm. Cut from specimen 87461	No. 1	536
QUARTZ (CITRINE), Brazil. Step-brilliant, rectangular girdle; deep	J. <b>J. 1</b>	
yellow; 10.94 carats; 17 by 11 by 8. Exhibited with specimen 44678	No. 1	1521
QUARTZ (CREOLITE), Hart, San Bernardino County, California. Tabu-		
lar, rectangular girdle; brown, light and dark banded; 10.56 carats; 18 by		
15 by 4 mm. With specimen 86943	No. 1	544

QUARTZ (CREOLITE), Hart, San Bernardino County, California. Cabo-		
chon, elliptical girdle; mottled white and brown; 8.34 carats; 25 by 9 by		
5 mm. With specimen 86943	No. 1	L5 <b>4</b> 3
QUARTZ (ROSE), twelve miles southeast of California Hot Springs, Cali-		
fornia. Nine stones, cabochon, seven elliptical, two circular girdles;		
pink; total weight, 30 carats; 19 by 8 by 5 to 8 by 4 mm. Cut from speci-		
men 87420	No.	1524
QUARTZ (ROSE), Scott Mine, Custer, South Dakota. Fifteen gems, cabo-		
chon, various girdles; pale pink; total weight, 62.57 carats; 20 by 8 by 4 to		
10 by 5 mm. Cut from specimen 87419	No.	1523
QUARTZ (SMOKY), Alexander County, North Carolina. Step-brilliant,		
elliptical girdle; smoky brown; 7.4 carats; 15 by 10 by 7 mm. With speci-		
men 92878	No.	1520
BHODONITE, Lemoncove, California. Ten stones, cabochon, elliptical	2.00	
and circular girdles; dull red and black, mottled; total weight, 46.5 carats;		
18 by 8 by 4 to 9 by 4 mm. Cut from specimen 87408	No.	1555
BHYOLITE (WABANITE), Wellesley, Massachusetts. Cabochon, ellipti-	110.	1000
cal girdle; gray and white banded; 10.42 carate; 19 by 14 by 4.5 mm. Cut		
from specimen 87468	N.	1559
SERPENTINE (SATELITE), Venice Hill, Tulare County, California.	110.	1999
Three stones, cabochon, elliptical girdle; gray-green; 13.94, 7.61, 2.81		
carats; 26 by 13 by 7, 18 by 13 by 6, and 15 by 8 by 4 mm. Cut from speci-	3T -	3550
men 87462	NO.	1999
SMITHSONITE, Kelly, New Mexico. Two stones, cabochon, elliptical		
girdle; green; 13.04 and 1.82 carats; 19 by 11 by 6 and 9 by 6 by 3 mm.		
Cut from specimen 87465	NO.	1557
SPODUMENE (KUNZITE), Pala, San Diego County, California. Bril-		
liant, circular girdle; pale pink; 2.035 carats; 8 by 5 mm. Cut from specimen 86882	No.	1565
STAUROLITE, Henry County, Virginia. Two specimens; 24 by 13, 18 by	_,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
15 mm	No.	1560
THOMSONITE, Grand Marais, Minnesota. Six specimens, cabochon,		
elliptical, and square girdles; mottled white, red-brown, etc.; total weight,		
40.315 carats; 15 by 8 to 11 by 5 mm. Cut from specimen 93426	No ·	1961
TOURMALINE, Auburn, Maine. Brilliant, circular girdle; blue-green; 1.02	110.	
carats; 7 by 5 mm. Cut from specimen 87204	No.	1561
TOURMALINE, Pala, San Diego County, California. Cabochon, ellip-	110.	1001
tical girdle; pink and green; 6.95 carats; 19 by 9 by 5 mm. Cut from		
encoimon 03104	No.	1569
specimen 93104	110.	1002
violet-red; 3.55 carats; 9 by 5 mm	N.	1569
TOURMALINE, Mesa Grande, California. Brilliant, circular girdle;	NO	1000
violet-red; 0.86 carat; 6 by 4 mm	N.	1564
	110.	1003
UNARITE, Milan's Gap, Madison County, Virginia. Cabochon, ellipitical		
girdle; mottled green and pink; 55.175 carats; 36 by 29 by 7 mm. (fig.	NT	
11, pl. 7). Cut from specimen 36784.	NO.	1258
VARISCITE, Columbus, Nevada. Fifteen stones, cabochon, mostly ellip-		
tical girdles; varying from greenish-white to green, brown, and black,		
mottled; 23.24 carats to 3.06 carats; 35 by 18 by 5 to 13 by 9 by 4 mm.		
	No.	1103
VARISCITE, Lucin, Utah. Nine gems, cabochon, elliptical and pear-		
shaped girdles; green and gray, mottled; total weight, 56.79 carats; 27 by		
20 by 5 to 10 by 8 by 4 mm. Cut from specimen 87416	No.	1102

VARISCITE (AMATRICE), Tooele County, Utah. Twelve stones, cabo- chon, elliptical girdle; varying from pale to dark green, mottled with	
brown and white; 13.67 carats to 1.94 carats; 22 by 15 by 6 to 11 by 7 by	,
4 mm. Cut from specimen 87402	No. 1105
VESUVIANITE (CALIFORNITE), Big Bar, California. Thirty-seven stones,	
cabochon, various girdles; green, some with matrix; total weight, 206.65	
carats; 30 by 13 by 8 to 9 by 5 mm. Cut from specimen 87409	No. 1539
VESUVIANITE (CALIFORNITE), Fresno County, California. Cabochon,	
elliptical girdle; green; 5.88 carats; 16 by 8 by 10 mm. Cut from specimen	
86945	No. 1541
VESUVIANITE (CALIFORNITE), Lindsay, California. Eleven stones, cabochon, mostly elliptical girdles; green; total weight, 56.4 carats; 23 by	
9 by 5 to 10 by 5 mm. Cut from specimen 87410	No. 1540

#### 2. IMITATION STONES.

The basis of most imitation gems is a very brilliant lead glass known as "paste" or "strass." Imitation gems may consist of paste alone, or of part paste and part stone, as in the "doublet" and "triplet." The one is made up of a table of a genuine stone, usually off-color, cemented to a pavilion made of a paste having the approved color. The other consists of a crown, table, and pavilion made of a pale or inferior stone, with a thin layer of colored glass at the girdle.

Imitation pearls are made by coating the inner surfaces of glass beads with a preparation made from the scales of certain fishes.

AMETHYST; eight stones, various cuts; red-violet; 25 by 13 to 10 by 7 mm AQUAMARINE; seven stones, various cuts; green-blue; 16 by 9 by 5 to 8 by 5	No. 1603
mm	No. 1596
CARNELIAN (artificially colored chalcedony); two stones, one table, rectangular, one cabochon, circular girdle; red-brown; 20 by 15 by 3 and	
16 by 7 mm	No. 1588
CAT'S-EYE; cabochon, four stones, circular and elliptical girdles; various	
colors; 19 by 8 to 13 by 7 mm	No. 1581
CHEYSOFRASE (artificially colored chalcedony); three stones, cabochon, elliptical girdle; green; 14 by 10 by 4, 12 by 8 by 4, and 13 by 5	
by 3 mm	No. 1580
DIAMOND ("Jagersfontein"); brilliant, circular girdle; colorless; 9 by	
6 mm	No. 1590
DIAMOND ("Light canary"); brilliant, circular girdle; pale yellow; 13 by	
9 mm	
<b>DIAMOND</b> ; 25 stones, brilliant, circular girdle; 15 by 10 to 7 by 5 mm	No. 1592
EMERALD (doublet); step-brilliant, rectangular girdle; green; 5.5 by 4 by	
3 mm. Mounted in a ring. Isaac Lea collection	No. 827
EMERALD (triplet); two stones, step, octagon girdle; green; 8 by 5 mm	No. 1607
EMERALD; eight stones, step and step brilliant, circular, octagonal, and	
square girdles; 20 by 12 to 8 by 4 mm	No. 1595
GARNET; two stones, cabochon, circular girdle; deep red; 10 by 7 and 8 by	
6 mm	
GEM STONE colored with uranium oxides; brilliant, circular girdle; 8 by	
5 mm. Gift of Capt. Harry Bryan	MO. 1010

TIANT NOTTE CHONE (-420-111-11-11-11-11-11-11-11-11-11-11-11-1		
HARLEQUIN STONE (artificially colored crocidolite); three stones, cabo-		
chon, circular and elliptical girdles; red, brown, and blue-gray; 16 by 7		1500
to 10 by 5 by 4 mm		
JADE; cabochon, elliptical girdle; green; 40 by 30 by 6 mm	No.	15/9
JADE; cabochon, circular girdle; dark green; 16 by 7 mm		1578
MOONSTONE; four stones, cabochon, pendant; colorless; 26 by 16 to 22		
by 10 mm	No.	1582
MOSS AGATE; cabochon, rectangular girdle; light brown with dark in-		
clusions; 19 by 12 mm	No.	1575
OLIVINE; three stones, brilliant and step, circular, square, and rectangue		
lar girdles; deep green; 12 by 8, 9 by 6, and 11 by 8 by 5 mm		
OPAL; two, one round, one bulb-shaped; iridescent colors		
PEARL; four round beads, white, 12 to 8 mm. diameter		
PEARL; four round beads; steel-gray; 12 to 8 mm. diameter		
PEARL; four round beads; very pale pink; 12 to 6 mm. diameter	No.	1584
ROSE QUARTZ; five stones, cabochon, various girdles; pale pink; 15 by		
15 by 6 to 15 by 10 by 5 mm	No.	1589
<b>BUBY</b> (doublet); step-brilliant, circular girdle; deep red; 10 by 5.5 mm	No.	1608
<b>BUBY</b> ; four stones, brilliant and step-brilliant; circular and square girdles;		
deep red; 13 by 7 to 8 by 4 mm	No.	1593
SAPPHIRE (doublet); two stones, brilliant, circular girdle; deep blue; 5 by		
3 mm	No	1609
SAPPHIRE; four stones, step-brilliant, circular and square girdles; deep		
blue; 12 by 6 to 4 by 3 mm	No.	1594
TOPAZ; three stones, step, rectangular and square girdles; pale pink; 34		
by 9 by 5, 11 by 8 by 5, and 8 by 6 mm	No.	1599
TOPAZ; cabochon, brilliant, and step-brilliant; various girdles; deep yel-		
low; 27 by 16 by 10 to 9 by 7 mm	No.	1597
TOPAZ; step-brilliant, elliptical girdle; very pale red-orange; 26 by 15 by		
10 mm	No.	1598
TOURMALINE; three stones; step-brilliant and brilliant, rectangular and		
elliptical girdles; deep pink; 12 by 10 by 5 to 6 by 5 by 3 mm	No.	1600
TURQUOISE; 30 stones, cabochon, circular girdle; average size, 4 by 2 mm		
TURQUOISE (artificially colored chalcedony); two stones, cabochon, cir-		
cular and elliptical girdles; blue; 16 by 6 and 20 by 6 by 3 mm	No.	1576

#### MODELS OF FAMOUS DIAMONDS.

CULLINAN, rough, and largest stone cut from it.

EMPRESS EUGENIE.

EXCELSIOR.

FLORENTINE.

GREAT MOGUL.

HOPE.

KOHINOOR, before and after recutting.

NASSAK.

ORLOFF.

PASHA OF PIGGOTT POLAR S
REGENT SANCY.
SHAH OF STAR OF

PASHA OF EGYPT.
PIGGOTT.
POLAR STAR.
REGENT OF PITT.
SANCY.
SHAH OF PERSIA
STAR OF THE SOUTH.

#### 3. ARTIFICIAL OR SYNTHETIC STONES.

A sharp distinction is to be drawn between the imitation of a gem stone and its formation by artificial methods. The imitation gem only simulates the natural substance; the artificial gem is identical with it. Examples of the latter class are to be found in the diamond as produced by heat and pressure in cast iron; the ruby as produced by the fusion of alumina with traces of chrome oxide; and the sapphire as made in a similar way.

#### LIST OF SPECIMENS.

#### 4. MODELS SHOWING FORMS INTO WHICH GEMS ARE CUT.

The cutting of many gem stones is necessary for the complete development of those properties upon which their beauty largely depends. In order that the inherent properties of a gem may be developed to the maximum it should be cut and polished in that form best suited to the exhibition of its beauties. The various styles of cut represented are:

Brilliant.
Old square cut brilliant.
English square cut brilliant.
Split brilliant.
Double brilliant.
Single brilliant.

Star.
Portuguese.
Rose.
Step.
Step.
Step brilliant.
Table.

# 5. SMALL ORNAMENTAL OBJECTS NOT USED FOR PERSONAL ADORNMENT.

The materials listed and described below, while in some cases of the same mineralogical nature as the gems described above, are not utilized for the most part for personal adornment, but as small ornaments and works of art. Their beauty is dependent in some cases on that of the material, in others the art of the lapidary is largely responsible for their attractiveness.

# AGALMATOLITE-PAGODITE.

The material known by this name is a soft stone of compact texture which may consist of pyrophyllite, an aluminum hydrous silicate, or tale, a magnesium hydrous silicate. The color is gray when pure, but often bluish, greenish, brownish, or yellowish, or mottled with different colors due to the presence of iron in various forms. The luster is dull, waxy. The material occurs usually in metamorphic rocks, chiefly crystalline schists. The commercial sources are China and Japan, where it is used extensively for carving grotesque images and objects of art which are frequently sold to the unwary under the name of jade, from which it can readily be distinguished by its softness.

Vase, carved with figures of birds and flowers; green-gray with pale red tint-		
ing; 22.5 cm. high, 12.5 cm. greatest width. China	No.	1651
Vase, carved with figure of deer, birds, and flowers; red and black mottled		
on dark base; 26 cm. high, 18 cm. wide. China	No.	1655

Vase, carving of vine; very pale green-gray on brown base; 25 cm. high.		
China		
China		
China		
Vase, gray-green and dark brown, on brown base; 12 cm. high, 4.5 cm. wide.  China		
Urn with carved handles and cover; mottled red, gray, and light brown; 18		
by 21 cm. China		
20.5 by 90 cm. China		
Carved piece, rectangular, lattice-work sides; light green-gray; 9 by 4.5 by 4 cm. China		
Group of five baboons; light gray-green; 17 cm. high. China		
Two Chinese priests on dark pedestals, one red mottled with gray-green; one		
gray-green; 22.5 cm. high. China		
Three Chinese figures on end of pedestal; gray-green faintly mottled with red. China		
Carving of a bird in a tree; yellow-brown. China		
Small Chinese figure on a pedestal; brown-red. China		
Ash tray, carved with leaves; gray; 10 by 6.5 cm. China		
Ash tray, carved with small trees; red-brown and gray; 12 by 7 cm. China No. 1664		
Ash tray: carved with leaves and fruit; red-brown and gray, 11 by 5.5 cm.		
China		
Carved tray; red-brown and gray; 22 by 16 cm. Japan No. 1661		
AMAZONSTONE.		
LIST OF SPECIMENS.		
Two spheres; green; 40 and 37 mm. diameter; Amelia Courthouse, Virginia.		
Isaac Lea collection		
CATLINITE—PIPESTONE.		
This material is an indurated clay or argillite. The prevailing colors are dull reddish, often more or less mottled with white. It occurs in Minnesota and South Dakota intercalated with other sedimentary rocks and was formerly used by the Sioux Indians for the making of pipes, and more recently has been used for small ornaments and paper weights. It is soft and readily carved.		
LIST OF SPECIMENS.		
Indian head carved on rectangular block; dull red; Minnesota		
CHALCEDONY.		
LIST OF SPECIMENS.		
Paper weight, pentagonal dodecahedron; blue (artificially colored); 6.5 cm.  Isaac Lea collection		
Snuff box; blue (artificially colored); 42 by 30 mm		

# CHALCEDONY, variety AGATE.

Thin polished slab gray with green inclusions; 14.5 by 9.5 cm. Brazil	No. 1733
Cube with truncated edges; red and gray; 5 cm. Brazil	No. 1716
Penholder; brown and white banded; 16.9 cm. long. Germany. Isaac	
Les collection	No. 1717
Seal handle; brown; 5.7 cm. long. Germany. Isaac Lea collection	No. 1736
Cane head; red, banded; 5.2 cm. long. Germany. Isaac Lea collection	
Seven snuff boxes; various colors and sizes. Oberstein, Prussia. Isaac Lea collection	
Dish; brown, banded with white; 10.7 by 9 cm. Oberstein, Prussia.  Isaac Lea collection	
Dish; red, banded; 8 by 6.2 cm. Oberstein, Prussia. Isaac Lea col-	
lection	
Prussia	
Cube; brown; 4 cm. Oberstein, Prussia	No. 1757
Cube with truncated edges; black, banded with white; 4.5 cm. Isaac Lea	
collection	
Two spheres; brown and white banded; 7.7 and 5.4 cm. diameter	
Seal handle; brown, banded; 8.6 cm. long. Gift of Dr. Robert Fletcher Paperweight, with round knob engraved with human face; dark brown;	
12.3 by 8.3 cm	No. 1726
Anzell	No. 1700
Book; brown and black with white banding; 10 by 5.5 cm	No. 1721
banded; 8.5 by 5.5 cm. Bequest of William H. Forwood	No. 1774
Paper knife; red banded; 15 cm. long. Bequest of William H. Forwood	
CHALCEDONY, variety BLOODSTONE.	
Two snuff boxes; green mottled with red; 40 by 25 mm. India	No. 1461
CHALCEDONY, variety CARNELIAN.	
Elliptical slab; red and yellow; 12 by 10 cm	No. 505 No. 504
CHALCEDONY, variety JASPER.	
Paper weight; red and yellow; 16.5 by 10 by 1.9 cm. Orenburg, Ural Mountains, Russia	No. 1713
Paper weight; green and red; 9 by 6.3 cm. Siberia	No. 1714
Small carve, piece, monument-shaped; green, red, and dark gray; 9.7 cm. high	
CHALCEDONY, variety MOSS AGATE.	
Paper cutter; green and gray; 35 cm. long. Germany. Isaac Lea collection	No. 1720
CHALCEDONY, variety SILICIFIED WOOD.	
Sphere; violet red and red, banded; 11 cm. diameter. Chalcedony Park,	<b>37</b>
Arizona	No. 1767
Dish; brown mottled; 12.5 by 8.5 cm. Chalcedony Park, Arizona	
Four polished slabs; red predominates; 21 by 15.5, 21 by 12, 17 by 16.5,	No. 1689

130 BULLETIN 118, UNITED STATES NATIONAL MUSEUM.
Polished slab; gray; 17 by 17 cm. Chalcedony Park, Arizona
Paper weight; yellow and red-brown, and gray; 10.2 by 7 by 2 cm
COAL.
Rectangular slab carved with a bunch of flowers; 15 by 10.5 cm
CROCIDOLITE.
LIST OF SPECIMENS.
Paper weight; cark blue-black; 11 by 8 cm. Griqualand, South Africa No. 1744 Dish; brown in white quartz; 13 by 9 cm. Griqualand, South Africa No. 1745 Half sphere; brown; 5.5 cm. diameter; Griqualand, South Africa. Isaac Lea collection
Sphere; brown; 3.8 cm. diameter. Griqualand, South Africa No. 1747
FLUORITE.
LIST OF SPECIMENS.
Cup on black marble base; dark purple; 10 cm. diameter. England No. 1754 Two ash trays; mottled; 8.7 and 8.5 cm. England No. 1755
GRAPHIC GRANITE—PEGMATITE.
This is a variety of pegmatite in which the quartz and feldspars have crystallized in long, parallel prisms which on cutting at right angles to the axis of elongation give rise to peculiar figures suggestive of letters of the Phoenician alphabet, hence the name <i>Graphic</i> . The light color and slight contrast of the two principal minerals render the material of little interest from a gem standpoint, but of considerable interest when cut into ornaments.
LIST OF SPECIMENS.
Ash tray; light brown; 14 by 8.2 cm.       Siberia
GYPSUM, variety SATINSPAR.
LIST OF SPECIMENS.
Goose egg; white; 9.5 cm. long.         Bridgeford, England
JADE.
LIST OF SPECIMENS.
Paper weight in form of a lotus leaf; dark green; 15 by 6 cm. China. No. 1701 Carving in the form of a vase; gray-green; 14 cm. long. China. No. 1702 Inkstand on a base of teak; light green. China. No. 1705 Vase on a base of teak; gray-green; 11.5 cm. high. China. No. 1704 Small bird mounted on gold stand; light green. China. No. 1703

# LABRADORITE.

#### LIST OF SPECIMENS.

Medallion of a	knight's head; gray, blue, green, etc., in play of colors; 10.5		
by 7.5 cm.	Labrador	No.	1750
Small monum	ental shaped object; gray; 10 cm. high. Labrador	No.	1749

# LEPIDOLITE.

A lithia mica of a pink color and sometimes sufficiently compact to be carved into small ornaments. It occurs associated with gem minerals (tournaline) in the pegmatite quarries of Maine, California, and elsewhere.

# LIST OF SPECIMENS.

Ash tray; rectangular; violet-red; 9 by 4.7 by 1.3 cm. Rozena, Moravia.		
Gift of C. S. Bement	No.	1748

# MALACHITE.

# LIST OF SPECIMENS.

Cube with truncated edges; green; 5 cm	a. Morenci, Arizona	No. 1696
Composite slab; green; 11 by 8.5 cm.	Ural Mountains	No. 1697

# MARBLE, CALCITE, and ARAGONITE.

Calcium carbonate occurs in nature under a great variety of forms, usually included under the mineralogical names of calcite and aragonite, or occurring in large rock-like masses as limestone and marble. The last named forms are used extensively in building and the finer grades (marble) for decorative work, statuary, and ornaments. Travertine, cave marble, and onyx marble are the names given to deposits on the surface or in caves and crevices in limestone, from water solutions. These are sometimes of exceptional beauty. The so-called oriental alabaster used by the ancient Egyptians was a travertine found in caves and fissures in the Eocene limestone of Egypt. Lumachelle is a name given to a variety in which the included shell fragments still retain their original nacreous or pearly luster. Other varietal names are given according to origin, color, and structure. These are to be found in the collection of building and ornamental stones. (See also under coral and pearl, pp. 31 and 77.)

Sphere of onyx marble; green-yellow; 9 cm. diameter. Big Buck Creek,	No. 1766
Sphere of travertine; pale yellow; 7.8 cm. diameter. Yavapai County, Arizona.	
Carving of a dragon on black limestone. Japan	No. 1689
Paper knife of onyx; 19.2 cm. long. Puebla, Mexico	
45559911	

Paper weight of onyx with irregular oval handle; base white, handle redbrown, mottled; 8 by 5.5 cm. Puebla, Mexico	No. 1835
Carved ornament in imitation of fruit; banded onyx; 6.7 cm. diameter.  Mexico	NT. 1751
Model of mounted cannon of stalagmite. Rock of Gibraltar	No. 1692
Paper weight of onyx; pale green; triangular; 6.5 cm. Near Upper Soda	
Spring, Siskiyou County, California	No. 1691
Paper weight of fossil coral; gray; 8.5 by 7.5 by 4.5 cm. Iowa	No. 1699
Paper weight of fossil coral; gray-brown; 7.9 by 6.5 by 3.4 cm. Iowa	No. 1834
Paper weight of fossil coral; dark gray brown; 5.7 by 3.9 by 2 cm. Gift of	
E. F. Boss	No. 1693
Paper weight; brown, mottled; 11 by 6.5 cm. Colusa County, California.	No. 1724
Conch shell with cameo engraved on one side; white and brown. West	
Indies	No. 1752

# MOSAIC.



FIG. 15.—LIZARD CARVED IN OPAL ON LIMONITE.

Mosaic slab of the 17th century, made of agate and lapis-lazuli. Russia... No. 1707 Mosaic paper weight made of agate, quartz, jasper, etc. Russia......... No. 1706

# OPAL.

LIST OF SPECIMENS.

Carving of a lizard on a base	ı
of limonite; blue.	•
Queensland, Australia	
(fig. 15)	No. 1043
Paper weight; pale yellow;	
5.7 by 2.3 cm. Noto,	
Japan	No. 1743

# QUARTZ.

Polished elliptical slab inclosing rutile needles; 12.2 by 9.5 by 1.5 cm.	
Madagascar	o. 175 <b>3</b>
Two small prisms inclosing hairlike tremolite needles; 50 by 10 and 45 by	
23 mm. Isaac Lea collection. Japan	o. 1 <b>672</b>
Carved seal handle of pale yellow quartz, inclosing rutile needles; 64 by	
40 mm	o. 1681
Seal handle of amethyst; red-violet. Germany. Isaac Lea collection No	o. 1 <b>694</b>
Small basin of beekite carved in a mass of fossil coral; yellow. Devon,	
England	o. 1756
Knife handle of citrine quartz; yellow; 7.5 cm. long. Switzerland No	o. 1680
Carved turtle of rock crystal; colorless. Japan. Isaac Lea collection No	o. 1 <b>677</b>
Carved seal of rock crystal; colorless; 7 cm. long. Mursinsk, Russia No	o. 1671
Carved eagle; colorless; 58 mm. Siberia	o. 1670
Drawer knob of rock crystal; colorless; 61 by 18 mm. Siberia No	
Knob of rock crystal; colorless; 57 by 6 mm. Switzerland No.	

Arrow heads of rock crystal; colorless; 15 specimens, average size 40 mm. long. Red Hill, near Bakersville, North Carolina. Isaac Lea collection Sphere of rock crystal; colorless; 11 cm. diameter. Chestnut Hill Township, Ashe County, North Carolina. Isaac Lea collection Sphere of rock crystal; colorless; 7.3 cm. diameter Sphere of rock crystal; colorless; 48 mm. diameter Three small spheres of rock crystal; colorless; 25 mm. diameter Seal handle of rock crystal; colorless; 4.4 cm. long. Bequest of William H. Forwood Sphere of rose quartz; pale pink; 42 mm. diameter. Albany, Oxford County, Maine. Isaac Lea collection	No. No. No. No. No.	1673 1674 167 1676 1778
RHODONITE.		
LIST OF SPECIMENS.		
Ash tray; red with black inclusions; 14.5 by 8.2 cm. Ural Mountains  Polished slab; red; 11 by 7.7 cm. Ural Mountains		
SERPENTINE.		
LIST OF SPECIMENS.		
Carving of an antique lamp; dark and light green. Newburyport, Massachusetts. Isaac Lea collection.  Sphere; green; 5.9 cm. diameter. Montville, New Jersey.  Diamond-shaped slab; green; 10.8 by 7.1 by 3.5 cm. Near Montville, New Jersey.  Cylindrical paper weight; dark green; 6.5 by 2.7 cm. Lizard Point, Cornwall, England.  Vase; green-gray with black veins; 20 cm. high. Gift of W. H. Abbott  Monument-shaped piece of bowenite; light green; 6.5 by 4 by 2.2 cm. Smithfield, Rhode Island.  Sphere; green and white banded; 7.2 cm. diameter. Gila Bend, New Mexico.	No. No. No. No.	1771 1762 1742 1698 1690
SOAPSTONE.		
LIST OF SPECIMENS.		
Paper weight; mottled green and brown; 8.2 by 8.2 cm. Santa Catalina Island	No.	
TALC.		
LIST OF SPECIMENS.		
Carving of a turtle; green-gray. India	No.	1710
UNCLASSIFIED.		
Carvings of fruits mounted on a tablet: Red currants, carnelian; white currants, rock crystal; blackberries, black chalcedony and serpentine; raspberries, rhodonite and amethyst; red cherries, carnelian; black cherries, black chalcedony; leaves, serpentine; base, jasper and black chalcedony. Ekaterinburg, Russia.	No.	1709

#### 6. OCCURRENCE AND ASSOCIATION OF PRECIOUS STONES.

Under this heading are included exhibits designed to illustrate the occurrence and association in nature of the various stones described in the preceding pages. These are (1) a comparatively small miscellaneous collection of specimens from various sources showing the rough gem material embedded in or associated with other minerals as found; (2) a larger collection arranged in what is known as an American case, and comprising the Gardner F. Williams collection illustrating the occurrence of the diamond in South Africa; (3) the granite pegmatites and their associated minerals from the eastern United States and southern California, the last named exhibited in the Geological Hall on the first floor.

#### 1. MISCELLANEOUS SERIES.

This comprises two cases in one of which is shown a variety of gem minerals, including both precious and semiprecious stones, either in the matrix or in the rough state as found in nature. The other contains precious opal in the matrix and includes examples from Australia and Mexico, as well as from the more recently discovered field in Humboldt County, Nevada, which furnishes a great variety of colors, ranging from the so-called "black opal" to the pale, iridescent shades.

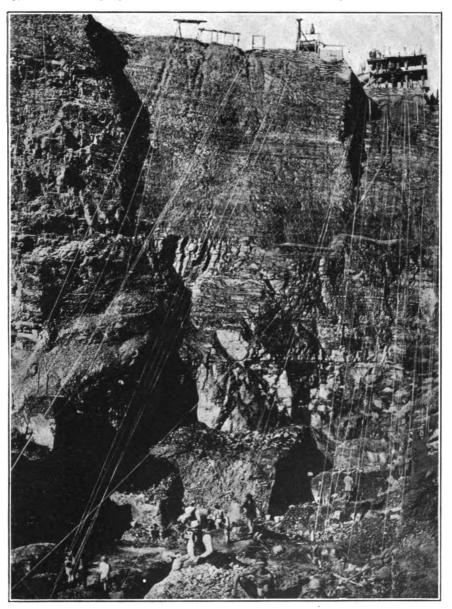
#### 2. DIAMOND-BEARING ROCKS OF SOUTH AFRICA.

The South African collection comprises about 100 specimens of rocks and mineral concentrates typical of the mines, together with illustrations in the form of photographs and engravings. Below is given a transcript of the label accompanying the collection.

#### SOUTH AFRICAN DIAMOND MINES.

[Collections illustrating the occurrence of diamonds in the De Beers Consolidated Mines (Ltd.), Kimberley, South Africa. Gift of Mr. Gardner F. Williams.]

The country rock immediately below the surface soil is an olivine diabase, locally called basalt (specimen no. 75898). Below this is a dark shale (specimen no. 75902) which is succeeded by a melaphyr (specimen no. 75910), and this by quartzite (specimen no. 75920). Through all of these have been extruded the diamond-bearing peridotite-breccia, shown in its fresh condition in specimen no. 75,933, and in the decomposed condition known as "blue ground" in specimen no. 75,932. The diamonds are now regarded as having originated through the condensation of metallic carbides in the peridotite while at a great depth below the surface, and to have been brought up in the magma to their present position at the time of its intrusion. In specimen 87701 is shown a cavity from which was removed a large crystal. There are also shown a cast of a diamond crystal weighing 363 carats and several small very perfect crystals and rounded bits (bortz) of genuine diamonds.



SOUTH AFRICAN DIAMOND MINE.

# LIST OF ROCKS FROM THE SOUTH AFRICAN DIAMOND MINES IN THE GARDNER F. WILLIAMS COLLECTION.

[From De Beers Consolidated Mines (Ltd.), Kimberley.]

Below is given a complete list of the rocks from the various shafts together with the depths below the surface at which they were found to occur:

#### DU-TOITS-PAN SHAFT.

Museum number.	Kind of rock.	Position in shaft.
75897	Decomposed basalt.	Feet. 19- 52
75898		52- 94
75899	Hard basalt	94-121
75900	Fine grained basalt	121-125
75901	Gray shale	125-132
75902	Black shale	
75903	Sandy shale	
75904	Black shale	162-364
75905	Glacial conglomerate	364-370
75906	Glacial conglomerate. Glacial conglomerate at contact with quartzite.	370
75907	Glacial conglomerate with embedded boulder	370
75908	Quartzite	370-452
75909	Diorite—(a) light color; (b) dark color	452-484
75910	Amygdaloidal diabase. Melaphyre (?)	484-515
75911	do	515-556
75912	do.	
75913	do.	
75914	do.	750-775
75915	do.	750-775
75916	do.	750-775
75917	do.	750-770 750
75918	Dyke between hard rock and blue ground	750 750
75919	Dyke between hard rock and blue ground	750
10919	Hard blue ground	750

#### DE BEERS SHAFT.

75920	Quartzite.	800
75921	do	
75922	Quartz porphyry	
75923	Amygdaloid dyke (?)	1, 440
75924	do.	
75925	Quartz porphyry	
75926	do.	1, 560
75927	Dyke.	
75928	Dyke (?)	
75929	Quartz porphyry	
75930	Quartz porphyry dark	1, 720
75931	Snake rock. Blue ground matrix	300
75932	Soft blue.	1,720
75933	Hard blue	1, 720
75934	do	
75935	Biotite	(1)
75936	i)	• • •
75937	Concentrates	
75938		
	1	

¹ From crater, about 1,400-foot level.

#### KIMBERLEY SHAFT.

Museum number.	Kind of rock.	Position shaft.
======================================	O	Fed.
75939	Quartzite	1,0
75940	Altered shale	
75941	Mixture, quartzite, etc	
75942	Diabase with amygdaloid.	1,5
75943	Quartz porphyry dodo	1,5
75944	Darale 321-	1,5
75945	Basalt dike	1,8
75946	Porphyry (?)	1,8
75947	Quartz porphyry	1,8
75948	do	2,1
75949	do	2, 1
75950	Basalt dike	2, 1
75951	Metamorphosed shale	2, 4
75952	Shales.	2,5
75953	Dyke	2, 5
75954	Soft blue ground	2,0
75955	Hard blue ground	1,8
75956	do	2,5
75957	<u></u>	1
75958 75959	Concentrates	
	BULLFONTEIN SHAFT.	
75960	Peridotite	2
75961	Quartzite	6
75962	Olivine diabase	ő
75963	Blue ground	4
75964	Blue ground north side of mine.	
75965	Blue ground south side of mine.	6
75966	)	"
75967	Concentrates	
75968	Society was a second and a second a second and a second a	
	PREMIER MINE.	
	[	
75969	Blue ground south side of mine	50
75970	Blue ground north side of mine	56
75970 75971	Blue ground south side of mine	
75970 75971 75972	Blue ground north side of mine	56
75970 75971	Blue ground north side of mine	56

#### 3. GRANITE PEGMATITES AND THEIR ASSOCIATED MINERALS.

The term "pegmatite" is applied to an interesting and peculiar type of igneous rock which occurs in the form of intrusive dikes and sheets, and is characterized as a rule by a coarse and extremely variable crystallization. The granite pegmatites consist for the most part of the same minerals as compose ordinary granite—that is, of quartz and feldspar, with or without mica—but are often accompanied by a considerable number of accessory minerals, which make them favorite hunting grounds for the collector. Crystallization sometimes takes

place on a gigantic scale, even to the formation of individuals several feet in length, though as a rule much smaller. At times the quartz and feldspar crystallize contemporaneously in long, parallel, skeleton, and enfolding prisms, giving rise to forms which when cut across resemble ancient Greek or Phoenician characters. Such forms are called graphic granite. The quartz and feldspar of the pegmatites are mined for use in pottery manufacture, the mica for electric and other purposes, while the beryls and the tourmalines, if of good color, are utilized as gems.

The pegmatites are common features of granitic rocks, and are found in greater or less abundance in nearly all of the states along the Appalachian chain, as well as in many of the regions west of the front range of the Rocky Mountains:

Two collections of these interesting rocks are shown, one from the Appalachians of the eastern United States, and one from the celebrated gem regions of southern California. Each comprises upward of 100 specimens showing the rocks in the rough and cut and polished conditions, and the associated minerals. In each case, and in the California series in particular, space is given to the decomposed and disintegrated material from the middle or "pay streak" portion together with examples of the same amount of material separated into its component minerals. The gem minerals from the California region, it should be mentioned, are mainly tourmalines of a pink and green color, and the variety of spodumene known as kunzite. Those from the Appalachians are mainly green tourmaline and the variety of beryl known as aquamarine.

#### A. THE APPALACHIAN PEGMATITES.

Among the more prominent objects in the Appalachian series are several large specimens showing (1) a pegmatite intrusion some 6 inches in width in gneiss, from Auburn, Maine (39058), (2) one of similar nature, 4 inches in width, bordered by a thin black tourmaline, in granite, from Cape Elizabeth, Maine (62508), (3) a thin zone of pegmatitic material with very obscure outlines in the Rockport, Massachusetts, granite (38757). There is also a large rough pegmatite from Amelia, Virginia (88983), and a fine large polished slab from Auburn, Maine (74795), cut across the grain, showing to advantage the "graphic" structure. Among the smaller and associated minerals are crystals of muscovite, showing the characteristic hexagonal outline (62377), masses of the lithia mica, lepidolite (90229), and the feldspar orthoclase or microcline (49700), amazonstone (48721), and albite (48723); also large masses of black tourmaline (89944); green radiating tourmaline in matrix (82268, 89939) and examples of beryl (90244), including the variety emerald in matrix from North Carolina (53778). The gem minerals (90223) occur associated mainly with the albitic feldspar and the lepidolite, as in the examples from Portland, Connecticut.

Other associated minerals shown are lithiophilite from Grafton, New Hampshire (88253); apatite from Strafford, New Hampshire (87435); allanite from Crown Point, New York (90262); gadolinite from Barringer Hills, Texas (88442); and uraninite from Mitchell County, North Carolina (59329).

# B. THE MESA GRANDE, CALIFORNIA, PEGMATITES.

The California series was prepared with great care and elaboration by Dr. W. T. Schaller, of the United States Geological Survey and at the same time honorary custodian of gems and precious stones in the National Museum. The details of the collection as given by him are as follows:

The nearly flat-lying pegmatite dikes, from which most of the specimens shown were obtained, crop out on the hills north and east of Pala, San Diego County, California, and are of the compound, unsymmetrical type whose different parts are thought to be due to differentiation processes rather than to multiple injections of material into reopened fissures. The upper portion of the dike is locally known as the "top rock" (nos. 89549, 89550) and is a mixture of a coarse, granular aggregate of quartz and feldspar and of a graphic pegmatite. No gem stones are found in this "top rock." The lower portion of the dikes, locally called the "bottom rock" (no. 88551), is a much finer grained granular quartz-albite rock characterized by numerous wavy bands of brownish-red garnets. These bands lie nearly horizontal in their general trend, being parallel to the slight dip of the dike. The "bottom rock" is likewise free from gem stones, but both it and the "top rock" are of great interest from the scientific point of view. Between the "top rock" and the "bottom rock" is the middle portion, called the "pay streak" by the miners, in which the gem minerals of value are found. Here also occur the cavities or pockets which often yield an abundance of the wellcrystallized minerals shown in the exhibit.

The top horizontal shelf on the south side of the exhibition case contains the granitic (no. 89871) and gabbro country rock (no. 88556) and also the partly altered gabbro—a loose, friable rock—and the completely altered gabbro (no. 89856), which as a brown iron-stained clay has been washed into the cracks and seams of the pegmatite rock. Where such a crack extends into a pocket the clay has coated the gems and associated minerals found therein. There are shown, for example, white feldspars of the pegmatite coated with the brown clay derived from the gabbro country rock. The origin of the clay of the gem pockets is thus explained.

The second horizontal shelf on the south side contains different varieties of the "top rock," consisting of graphic pegmatite and granular pegmatite. The third horizontal shelf shows the mineral aggregates of the middle part or "pay streak," which yields on decomposition the loose, friable material forming the gem pockets. This same shelf also shows examples of the banded "bottom rock."

The sloping shelf on the south side contains large specimens of the different varieties of the pegmatite rock, including granular, graphic, and banded pegmatites. Several of these larger specimens have been sawed and polished and are well adapted for use as an ornamental stone, especially when cut obliquely so as to form wavy lines and circular effects resembling bird's-eye wood. One specimen in particular consists of a large section of the entire pegmatite dike and shows the aggregate of lithium minerals in the upper portion or "top rock," the granular pegmatite of the middle portion, and the banded "bottom rock." (No. 88560.)

The sloping shelf on the north side of the case illustrates the mineral contents of the gem pockets. A sample of the gem-bearing clay or pocket material is first shown, below which is an equal amount of similar gem clay separated into its constitutent minerals; thus the relative proportions of the gem tourmaline, the clay washed into the pocket from the decomposed gabbro country rock, and the various minerals associated with the gem tourmaline are exhibited. For example, the pocket material from the Tourmaline King mine (no. 90312 and 90308), at Pala, shows much lepidolite, orthoclase, clay, and gem tourmaline (pink and green), and smaller amounts of muscovite and quartz. Similar gem-bearing clay from the Tourmaline Queen mine, at Pala (no. 90307), shows, in addition to much pink tourmaline, large amounts of clay, quartz, albite, and cookeite, but practically no orthoclase. A gem pocket from the Ed. Flethcher, jr., mine, at Pala (no. 90310), shows, in addition to much pink tourmaline, clay, and albite, a considerable amount of lepidolite, with only a little orthoclase. A gem pocket from the Pala Chief mine, at Pala (no. 90310), shows considerable gem kunzite, with lepidolite, quartz, clay, cookeite, and orthoclase, and smaller amounts of albite and muscovite. A similar pocket from the Caterina mine at Pala (no. 90311) shows only spodumene, pink clay, and quartz. The exhibit also includes a pocket containing an abundance of small blue tourmalines; a small pocket from the Tourmaline King mine, very rich in gem tourmalines; and several pockets free from any gem stones. Such pockets are known by the miners as "dead ones."

On this same sloping shelf are shown also several large specimens of the minerals associated with the gem pockets. Among these minerals may be noted a fine example of orbicular muscovite, an altered perthite (feldspar) crystal, a large amblygonite crystal, and several specimens of spodumene (kunzite) in the matrix. These kunzite specimens are very difficult to collect, as in general the matrix of the kunzite is so friable that it breaks to pieces when it is taken out of the mine.

The three horizontal shelves above the sloping shelf on the north side of the case contain well-developed and well-crystallized specimens of the different minerals found in the gem-pocket zone of the pegmatite dikes. Among these minerals may be noted in particular a good series of the various forms of lepidolite (nos. 88528, 88536) (including several well-crystallized specimens) (no. 89865), crystals of muscovite, fine tourmaline crystals (nos. 88165, 88166), albite and orthoclase in well-developed crystals, pink beryl (no. 89170), stilbite, cassiterite, a large crystal of lithiophilite bismuth, bismuthite, bismuthosphaerite, purpurite, hematite, and pyrite, apatite, pucherite, topaz, manganotantalite, a fine example of clear pink kunzite in the matrix (nos. 88538 and 90027), and the phosphate minerals first found in this locality, namely, palaite, salmonsite, and sicklerite.

#### APPENDIX 1.

#### THE CUTTING OF GEM STONES.

The cutting of gem stones is necessary for the complete development of those properties upon which their beauty largely depends. Rarely does the stone, as found in nature, present those qualities which make it attractive to the eye. In its natural state it is often opaque, dull, or flawed, and even if transparent and flawless its form is rarely adapted to the display of those characters which distinguish the fashioned stone. Occasionally a stone may, without artificial treatment, show to a sufficient degree those qualities which give it rank; but such cases are rare, and in order that its inherent beauty may be developed to the maximum it must be cut and polished.

The several styles of cut may all be brought under one or the other of the following heads: I. Those bounded by plane surfaces only. III. Those bounded by curved surfaces only. III. Those bounded by both curved and plane surfaces. The several examples under the above heads may be tabulated thus:

I. Bounded by plane surfaces:

Brilliant cut.
Double brilliant or Lisbon cut.
Half brilliant or single cut.
Trap or split brilliant cut.
Portuguese cut.
Star cut.
Rose cut, or briolette.
Step brilliant or mixed cut.
Table cut.

II. Bounded by curved surfaces:

Double cabochon cut. Single cabochon cut. Hollow cabochon cut.

III. Bounded by curved and plane surfaces—mixed cabochon cut.

# BRILLIANT CUT.

The brilliant cut may be described as two truncated pyramids, placed base to base. The upper pyramid is called the *crown*, and is so truncated as to give a large plane surface; the lower one, called the *pavilion*, terminates almost in a point. The line of union of the two pyramids is called the *girdle*, and is the widest part of the stone. This fashion of cut, though occasionally modified as to the size, mutual proportions, and even the number of facets, requires, when perfect, 58 facets. The uppermost facet is called the *crown*, and is formed by removing one-third of the thickness of the fundamental octahedron; the lowermost facet is called the *culet*, or *collet*, and is formed by

removing one-eighteenth of the thickness of the stone (a and b, in text fig. 16). The triangular facets touching the table (s in c, fig. 16) are called star facets; those touching the girdle fall into two groups, skill facets (E in c) and skew facets (D in c). The corner facets touching the table and girdle on the crown (B in c), and the culet and girdle on the pavilion (Q in d) are called quoins. The facets between the quoins, and touching the table and girdle when on the crown, and the culet and girdle when on the pavilion, are called, respectively, bezel

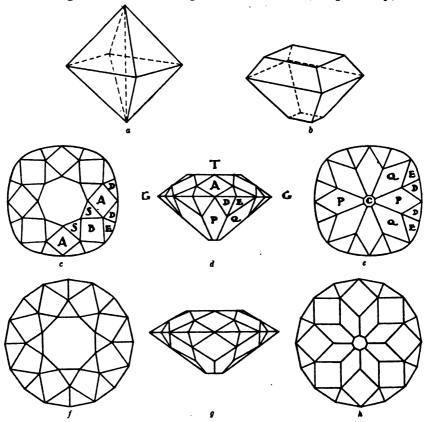


Fig. 16.—The Brilliant. a and b, manner in which the Brilliant is derived from the fundamental form; c, d, and e, top, side, and back views of Brilliant with 58 facets; f, g, and h, top, side, and back views of modified Brilliant with 66 facets.

facets (A in c) and pavilion facets (P in d). The total number of facets are distributed as follows: 1 table, 16 skill facets, 16 skew facets, 8 star facets, 8 quoins, 4 bezel facets, 4 pavilion facets, and 1 culet, as shown in c, d, and e of the text figures, representing the top, side, and bottom views of a brilliant with 58 facets. Occasionally the cut is modified by cutting extra facets around the culet, making 66 in all.

The brilliant cut is especially applied to the diamond, and when perfect should be of the following proportions: From the table to the

girdle, one-third, and from the girdle to the culet two-thirds of the total. The diameter of the table should be four-ninths of the breadth of the stone. When applied to other stones these proportions are more or less modified to suit their individual optical constants.

#### DOUBLE BRILLIANT CUT.

The double brilliant, or Lisbon cut, is a form with two rows of lozenge-shaped facets, and three rows of triangular-shaped facets,

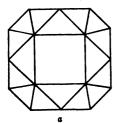


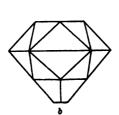
FIG. 17.—THE DOUBLE BRILLIANT. TOP (a), SIDE (b), AND BACK (c) VIEWS.

74 in all. The figure shows top (a), side (b), and bottom (c) views of this fashion.

HALF BRILLIANT CUT.

The half brilliant, single, or old English cut is the simplest form of the brilliant, and is generally employed for stones too small to admit





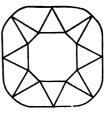
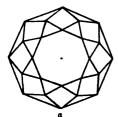
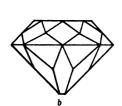


Fig. 18.—The half brilliant. Top (a), and side (b) views of the half brilliant. In c the top is cut in the form of a stab, then called english single-cut.

of numerous facets. The figure shows top (a) and side (b) views of this style of cut. Occasionally the top is cut so as to form a star (c in fig. 18) and then called English single-cut.





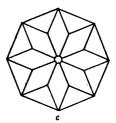


Fig. 19.—The trap brilliant. Top (a), side (b), and back (c) views.

TRAP BRILLIANT CUT.

The trap brilliant, or split brilliant, differs from the full brilliant in having the foundation squares divided horizontally into two triangular facets, making 42 in all.

#### PORTUGUESE CUT.

The figures show the top, side, and bottom views of the Portuguese cut, which has two rows of rhomboidal and three rows of triangular facets above and below the girdle.

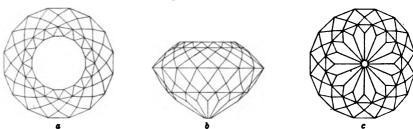


Fig. 20.—The portuguese cut. top (a), side (b), and back (c) views.

STAR CUT.

The figures show the front and back views of the star cut. The table is hexagonal in shape, and is one-fourth of the diameter of the

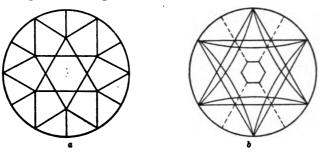


FIG. 21.—THE STAR CUT. FRONT (a), AND BACK (b) VIEWS.

stone; from the table spring six equilateral triangles, whose apices touch the girdle, and these triangles, by the prolongation of their points, form a star.

ROSE CUT.

The rose cut differs from the brilliant cut in that the crown consists of triangular or star facets, whose apices meet at the point or

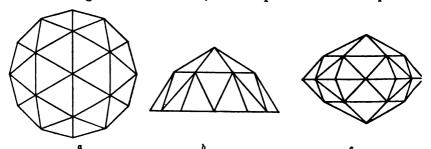


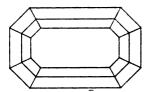
FIG. 22.—THE BOSE CUT (a) AND (b), TOP AND SIDE VIEWS; (c) SIDE VIEW OF DOUBLE BOSE.

Crown of the rose. The base lines of these star facets form the base lines for a row of skill facets whose apices touch the girdle, leaving

spaces which are each cut into two facets. The base may be flat or the bottom may be cut like the crown, making a double rose or briolette cut. The shape of a rose-cut stone may be circular, oval, or indeed any other that the rough gem may permit.

## TRAP OR STEP CUT.

In the trap or step cut the facets run longitudinally around the stone from the table to the girdle and from the girdle to the culet. There are usually but two or three sets of step facets from the table



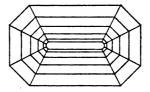


FIG. 23.—UPPER AND UNDER SIDES OF TRAP CUT.

to the girdle, while the number of steps from the girdle to the culet depends upon the thickness and color of the stone. The fashion is best adapted to emeralds and other colored stones.

## STEP BRILLIANT OR MIXED CUT.

Here the form from culet to girdle is the same as that of the trap cut, while from the girdle to the table the stone is brilliant cut, or the opposite.

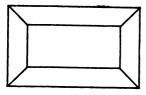




FIG. 24 .- THE STEP BRILLIANT CUT .

### TABLE CUT.

The table cut consists simply of a greatly developed table and culet meeting the girdle with beveled edges. Occasionally the 8 edge facets are replaced by a border of 16 or more facets.



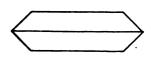


FIG. 25.—TOP AND SIDE VIEWS OF TABLE CUT.

### CABOCHON CUT.

The cabochon cut is usually applied to opaque, translucent, deep colored, or chatoyant stones. The double cabochon is usually cut

with a smaller curvature on the base than on the crown. The single cabochon is a characteristic cut for the turquoise. The hollow cabochon is adapted to very deep-colored transparent stones. The

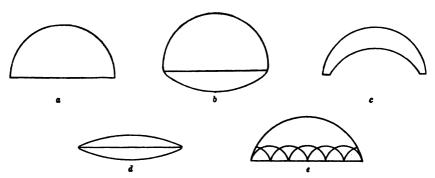


Fig. 26.—The cabochon cut. e, the single cabochon; b, the double cabochon; c, the hollow cabochon; d, flat or tallow top cabochon; e, mixed cabochon.

mixed cabochon has either the edge or side faceted, or both. In all of the cabochon cuts the arches may be of a varying degree of flatness, depending upon the nature of the stone.

## CAMEO AND INTAGLIO.

The term "cameo" is applied to any engraving in relief upon the surface of a gem, usually upon a stone like onyx or a shell composed of layers of different colors, the engraving being of sufficient depth to expose the underlying layers and producing the desired contrast. An intaglio differs in being an incised engraving and usually upon a stone of uniform color throughout.

## APPENDIX 2.

# GEMS MENTIONED IN THE BIBLE.

The Bible contains three lists of gems. The first of these is an account of the jewels on the *ephod* of Aaron. The *ephod* is described as having a front part and a back part fastened at each shoulder with an onyx mounted in gold and engraved with the names of the children of Israel, six on each stone, to memorialize the Lord of the promise made to them. (Exodus xxviii, 6, 12, 29.) The breastplate was made of the same material as the *ephod*, and folded so as to form a kind of a pouch in which the Urim and Thummin were placed. (Exodus xxxix, 9.) The external part of this gorget, or "breastplate of judgment," was set with four rows of gems, three in each row, each stone set in a golden socket and having engraved upon it the name of one of the twelve tribes of Israel. (Exodus, xxviii, 17–20.)

The following lists taken from Biblical antiquities by Adler and Casanowicz 1 give the names of these stone in the original and in the Septuagint, together with the meaning adopted by most authorities, the rendering of the Revised Version, both in text and margin being added in parentheses:

- 1. Odem (sardion), carnelian (sardius, ruby).
- Nofek (anthrax), carbuncle, probably the Indian ruby (emerald, carbuncle).
- 7. Leshem (ligyrion), jacinth, others, sapphire (jacinth, amber).
- (jacinth, amber).

  10. Tarshish (chrysolithos), chrysolite, others, topaz (beryl, chalcedony).
- 2. Pitdah (topazion), topaz or peridot.
- 5. Sappir (sapfeiros), sapphire or lapis lazuli (sapphire).
- 8. Shebo (achates), agate.
- 11. Shoham (beryllion), beryl (onyx, beryl).
- 3. Bareketh (smaragdos), smaragd or emerald (carbuncle emerald).
- 6. Yahalom (iaspis), onyx, a kind of chalcedon (diamond, sardonyx).
- 9. Achlamah (amethystos). amethyst.
- 12. Yashpeh (onychion), jasper.

In many instances the equivalent of the Biblical names of gems is uncertain in the nomenclature of modern mineralogy, and as a consequence there are several distinct lists of names given for the stones in the breastplate. In the Section of Comparative Religions in the United States National Museum is a very old silver breastplate employed as an ornament for the manuscript copy of the Torah, or Pentateuch, used in an ancient synagogue. The twelve stones, with the names of the

¹ Report of the U. S. National Museum, 1896, p. 943. A collection of these stones is on exhibition in the division of Old World Archaeology, Department of Anthropology.

twelve tribes, according to it are as follows: Garnet, Levi; diamond, Zebulon; amethyst, Gad; jasper, Benjamin; chrysolite, Simeon; sapphire, Issachar; agate, Naphthali; onyx, Joseph; sard, Reuben; emerald, Judah; topaz, Dan; beryl, Asher.

The second list is that given in the description of the ornaments of the Prince of Tyre (Ezekiel xxviii, 13):

	1	1	_
<ol> <li>Odem.</li> <li>Turshish.</li> <li>Sappir.</li> </ol>	2. Pitdah. 5. Shoham. 8. Nofek.	3. Yahalom. 6. Yashpeh. 9. Bareketh.	

The third list is that given in the description of the Heavenly City (Revelations xxi, 19, 20). As in the preceding list, the word used in the original, or Greek, is followed by the rendering given by most authorities, that of the Revised Version in parentheses:

1. Iaspis, jasper. 4. Smaragdos, smaragd	2. Sapfeiros, sapphire or lapis lazuli. 5. Sardonyz, sardonyx.	3. Chalkedon, chalcedony. 6. Sardios, sardius.
(emerald). 7. Chrysolithos, chrysolite. 10. Chrysoprasos, chrysoprase.	8. Beryllos, beryl.	9. Topazion, topaz. 12. Amethystos, amethyst.

In addition to the gems enumerated in these lists, there is mentioned the diamond by the Hebrew name of shamir (Jeremiah xvii, 1; Ezekiel iii, 9; Zechariah vii, 12); amber, Hebrew Hashmal (margin of Revised Version gives electrum) (Ezekiel i, 4); and crystal (quartz), Hebrew qerah and gabish (Ezekiel i, 22; Job xxviii, 18; Revelation iv, 6).

The complete list of gems mentioned being as follows:

Agate, Hebrew shebo.—One of the stones in the breastplate of judgment. (Exodus xxviii, 19.)

Amber, Hebrew hashmal.—Ezekiel i, 4. Some render the Hebrew leshem as amber, thus making it one of the gems in the breastplate. (Exodus xxvii, 19.)

Amethyst, Hebrew ahlamah.—One of the stones in the breastplate. (Exodus xxviii. 19). In Revelation xxi, 20, it is mentioned as garnishing the twelfth foundation of the heavenly Jerusalem.

Beryl, Hebrew shoham.—One of the stones in the breastplate. (Exodus xxviii, 20.) Mentioned as one of the ornaments of the King of Tyre. (Ezekiel xxviii, 13.) In Revelation it is spoken of as adorning the eighth foundation of the Holy City.

Carbuncle, Hebrew nofek.—One of the stones in the breastplate. (Exodus xxviii. 18; see also Ezekiel xxviii, 13). The word nofek has been rendered ruby.

Carnelian, perhaps the Hebrew odem of the breastplate (Exodus xxviii, 17), and the sardius in Revelation xxi, 20. In Revelation iv, 3, of the Revised Version, is the rendering sardius. In the Authorized Version the reading is: "And he that sat was to look upon like a jasper and a sardine stone." In the Vulgate: "Et qui sedebat similis erat aspectui lapidis jaspidis et sardinis." The Textus receptus (Greek) is: Καὶ ὁ καθήμενος ἡν ὅμοιος ὁράσει λίθω ἰαδπίδι; καὶ σαρδίνιω. All other editions have for

the last word, σαρδίω. It is evident that the Vulgate and the Authorized Version simply followed the Textus receptus, and that the correct rendering is "sardius" and not "sardine stone."

Chalcedony.—The Hebrew tarshish (Exodus xxviii, 20) has been rendered chalcedony. In Revelation xxi, 19, it is enumerated in the description of the foundation of the New Jerusalem.

Chrysolite.—(See Revelation xxi, 20.) The Hebrew tarshish (Exodus xxviii, 20) has been rendered chrysolite.

Chrysoprase.—One of the stones in the foundation of the Heavenly City. (Revelation xxi, 20.)

Diamond, Hebrew shamir.—(See Jeremiah xvii, 1; Ezekiel iii, 9; and Zechariah vii, 12, where it is spoken of as an object of extreme hardness. In the Authorized Version the Hebrew yahalom (Exodus xxviii, 18) is rendered diamond.

Emerald, Hebrew bareketh.—One of the stones in the breastplate. (Also see Revelation iv, 3.)

Jacinth, Hebrew leshem.—A stone in the breastplate. (Exodus xxviii, 19). The eleventh foundation of the Heavenly Jerusalem. (Revelation xxi, 20.)

Jasper, Hebrew yashpeh.—A stone in the breastplate. (Exodus xxviii, 20.) Mentioned as adorning the Prince of Tyrus (Ezekiel xxviii, 13.) One of the stones enumerated in the description of the Heavenly City. (Revelation xxi, 19.)

Onyr, Hebrew shoham.—One of the stones in the breastplate. (Exodus xxviii, 20; see also Genesis, ii, 12; and Ezekiel xxviii, 13.) According to certain renderings the shoham is beryl. Shohams set in gold were put on each of the two shoulder straps of the ephod of the high priest, and the two were engraved with the names of the twelve tribes, six on each. (Exodus xxviii, 12.)

Pearl.—It is thought that pearl is meant by the Hebrew peninim, a word often employed in the Old Testament as a figure of something valuable and precious. (See Proverbs, iii, 5; xxxi, 10, and Job xxviii 18.) Jesus uses the pearl for the same purpose in Matthew vii, 6, and xiii, 45.

Ruby, Hebrew nofek or odem.—One of the gems in the breastplate. (Exodus xxviii, 17; see also Ezekiel xxvii, 13.)

Sapphire, Hebrew sappir.—One of the stones in the breastplate. (Exodus xxviii, 18; also mentioned in Ezekiel xxviii, 13, and Revelation xxi, 19.) Some authorities render sappir as lapis lazuli, and not sapphire.

Sardonyz, Hebrew yahalom.—One of the stones in the breastplate. (Exodus xxviii, 18.)

Topaz, Hebrew pitdah.—One of the stones in the breastplate. (Exodus xxviii, 17; also mentioned in Ezekiel xxviii, 13, and in Revelation, xxi, 20.)

## APPENDIX 3.

## MYSTICAL PROPERTIES OF GEMS.

Man has endowed gems with talismanic, curative, and supernatural powers. Certain gems preserved him from incubi, vampires, and kindred terrors; others preserved him from the powers of sorcery or conferred the powers of witchcraft; by their aid he controlled the spirits of evil or was protected from their malign influence. With a suitable gem he could foretell the future, review the past, or conjure up pictures of events taking place at a distance. Protected by their mystic influences he feared neither plague nor poison, while his belief in the marvelous efficacy of their curative powers gave them a place among his most potent remedies.

The virtues of gems were diverse. Some procured the favor of the great; others rendered their possessors amiable, wise, strong, and brave; some protected him from fire, lightning, and tempests; others from danger and disease; some were preferred as talismans and charms; others were used as drugs, either alone or with electuaries, and with or without prayers, incantations, or other prescribed formulas.

Certain gems brought good or evil through the planetary influence of certain days. All yellow gems were appropriate for Sunday wear through the name giver, the sun. On Monday, the moon day, all white stones except the diamond were to be worn. Tuesday, the day of Mars, claimed garnets, rubies, and all red stones. Wednesday demanded blue stones. Thor's day, or Thursday, required amethysts and other stones of a sanguine tint. Friday, the day of Venus, had for its gem the emerald. Saturn's day claimed the diamond.

A particular stone was potent for good during a particular month, and, under the proper astrological control was supposed to have a mystical influence over the twelve parts of the human anatomy. Such a gem was the more potent if the natal day of the wearer corresponded with its particular sign, and when worn as a birth or month stone was supposed to attract at all times propitious influences and avert malign effects. The more important stones, their zodiacal control, and most potent periods of influence are:

Stone.	Zodiacal control.	Period.
Garnet	Aquarius	Jan. 21 to Feb. 21.
Amethyst	Pisces	. Feb. 21 to Mar. 21.
Bloodstone		
Sapphire	Taurus	
	Gemini	
Emerald		
Onyx		
Carnelian		
Chrysolite		
Aquamarine		
Topaz		Nov. 21 to Dec. 21.
Ruby	Capricorn	

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A closely related idea is found in the 12 stones which, according to the Jewish cabalists, when engraved each with an anagram of the name of God, were supposed to have a mystical power over, and a prophetical relation to, the 12 angels. Thus:

Ruby	.Malchediel.
Topaz	. Asmodel.
Carbuncle	.Ambriel.
Emerald	.Muriel.
Sapphire	.Herchel.
Diamond	.Humatiel.
Jacinth	.Zuriel.
Agate	.Barbiel.
Amethyst	
Beryl	.Humiel.
Onyx	.Gabriel.
Jasper	

These stones also had reference to the Twelve Tribes of Israel, the 12 parts of the human body, 12 hierarchies of devils, etc. By their aid a system of prognostication was practiced, based upon the change of hue or brilliancy of the stone, so that the cabalist was enabled to foretell future events.

The Twelve Apostles were represented symbolically by precious stones: Jasper, St. Peter; sapphire, St. Andrew; chalcedony, St. James; emerald, St. John; sardonyx, St. Philip; carnelian, St. Matthew; beryl, St. Thomas; chrysoprase, St. Thaddeus; topaz, St. James the Less; hyacinth, St. Simeon; amethyst, St. Matthias.

The superstitions connected with the 12 stones have persisted in one form or another from the times of the Magi to the present, and the belief in their virtues can still be traced in the wearing of "birthstones," as listed below:

#### BIRTH STONES.

January....Garnet (also hyacinth).
February...Amethyst (hyacinth and pearl occasionally used).
March....Bloodstone (also jasper).
April.....Diamond (also sapphire).
May.....Emerald (chalcedony, carnelian, and agate occasionally used).
June.....Agate (chalcedony, turquoise, pearl, and cat's-eye occasionally used).
July.....Ruby (carnelian, onyx, sardonyx, and turquoise occasionally used).
August....Sardonyx (carnelian, moonstone, alexandrite, and topaz occasionally used).
September..Sapphire (also chrysolite and sardonyx).
October....Opal (also beryl and aquamarine).
November..Topaz (also pearl).
December..Turquoise (ruby, bloodstone, and chrysoprase occasionally used).

In the Sympathia Septem Metallorum ac Septem Selectorum Lapidum ad Planetas is a list of stones recorded as being in sympathy with the planets, and as such were possessed of astrological and medicinal properties which, under the proper sign, rendered them of service to men. Thus—

[b] Saturn.... Turquoise, sapphire.

[24] Jupiter.... Carnelian, topaz, amethyst.

[&] Mars..... Jasper, emerald.

[2] Venus.... Emerald, amethyst, topaz.

[] Mercury... Crystal, agate, emerald.

[D] Moon..... Moonstone, topaz, and all white stones.

[ Sun..... Diamond, ruby.

The Hindu propitiated hostile stars by the bestowal of gems. If the sun was hostile, a pure ruby; the moon, a good pearl; if sani, a star affecting to a powerful degree the destinies of men, a sapphire. He also averted the evil effects of adverse astral influences by wearing certain stones. If the sun was adverse, the cat's-eye; if the moon, the sapphire, etc.

The mystic ascribed a certain significance both to the gem and to its various colors. For example, white was the emblem of light, purity, faith, innocence, joy, and life; worn by women it was emblematic of chastity; by the ruler, of humility and integrity. Red signified pure love and wisdom; in other sense it signified passion, love of evil, hatred, etc. Blue was indicative of truth, constancy, and fidelity. Yellow in one sense was symbolical of marriage and faithfulness; in another sense of inconstancy, jealousy, and deceit. Green was the color of hope, especially that of immortality. Amethystine signified love, truth, passion, suffering, and hopefulness, and among the Rosicrucians was symbolical of the divine male sacrifice.

Stones of all sorts were engraved with the figure of a cockatrice, which, under the proper planetary influence, were preservatives against the evil eye. The names of Jesus, Mary, and Joseph were engraved on stones, chiefly amethyst, onyx, and bloodstone, which were worn as preventives of contagious diseases; the larger the stone, the greater its efficacy. Gems were also supposed to indicate the state of health of the donor or wearer. If the stone became dull, opaque, or colorless it was thought to be significant of danger and death. In a similar manner they lost or changed color in contact with poisons.

Dreaming of gems was usually fraught with good, while seeing or handling them on the eve of a journey, or at certain phases of the moon, was regarded as auspicious.

Supernatural influences have been attributed to gems which still pass current. For example, an onyx ring, supposed to be the espousal ring of Mary and Joseph, exhibited in the Duomo of Perugia, is thought to be efficacious in the cure of every disorder. Amber is still used as a prophylactic and curative for goiter, croup, and diseases of the throat. The opal is thought by many to bring ill luck to the

wearer. The coral is still believed to be a charm against diseases of childhood, and is extensively worn in Italy as a protection against the "evil eye." Pearls are dreaded by some and favored by others. No French bride will wear them on her wedding day, since they would bring tears to her married life. In the East the believers are dogmatic in their faith, and it is heresy to assert that the use of gems has no practical influence over body or mind.

It is impossible here to do more than hint at the many beliefs concerning gems which were or are current, and the following notes merely suggest a few of the more prevalent beliefs on this subject:

Agate.—Emblematic of health and wealth. An enemy to all venemous things; assuages thirst when held in the mouth; gives victory to its wearer; repels storms; sharpens the sight; preserves and increases strength, and renders its wearer gracious and eloquent. (Camillus Leonardus, Speculum Lapidum, 1502.) Efficacious as an amulet against scrofula and skin diseases. (Albertus Magnus, De Vertutibus Herbarium, Lapidum, Animalum, etc.) Various properties are attributed to it by Mohammedan authorities. It cured insanity when administered with water or with the juice of the fruit Sheu (an apple?); a remedy for hemorrhage in the genital organs or in the rectum; for the spitting of blood; for the unusual discharge of the menstrual fluid. In conjunction with other medicines it cured hard boils and porous ulcers, gravel, spleen, and kidney troubles. It prevented bleeding of the gums and rendered them hard when applied to the parts as a calcined powder.

Agates having the reddishness of the water after washing raw flesh in the shape of finger rings prevent bleeding of all kinds. The wearer strikes terror to the heart of his enemies, obtains his heart's wishes from the gods, and becomes free from pain in the breast.

The Akik (agate) confers upon the wearer all the blessings that the use of the turquoise does. Its internal use may do harm to the stomach, but this can be avoided by mixing it with Kakira, or, in its absence, with the Basud stone. (Views of Arabic and Persian writers on gems and stones.)

If taken internally, the agate drives away fear, increases the power of digestion, cures insanity and monomania of that kind which creates the impression of being beaten and abused by others. If worn, it cures stricture and the vomiting of blood coming from the chest; worn on the neck, it cures the spitting of blood issuing from the lungs at the time of coughing. Calcined, powdered, and administered with white wine in doses weighing 16 barleycorns, it cured the gravel. If tied about the thighs of a woman under painful labor, it helps to a speedy and easy delivery. The weight of the stone here prescribed should be about 120 barleycorns. (Ben Adloulah.)

The eye-agate was considered efficacious as an amulet in cases of scrofula and other skin diseases. In great repute to-day in Syria as a curative for "Aleppo" sores.

Pierre de Boniface, writing in 1315, said:

The agate of India or Crete renders its possessor eloquent and prudent, amiable, and agreeable.

Ben Jonson, in the Alchymist, speaking of the medicinal properties of gems, wrote:

My meat shall come in Indian shells, dishes of agate set in gold, and studded with emeralds, sapphires, hyacinths, and rubies. The tongues of carps, dormice, and camel's heels boiled in the spirit of Sol, and dissolv'd pearl, apicus diet 'gainst the epilepsy. And I will eat these broths with spoons of amber, headed with diamond and carbuncle.

Dioscorides, in his Materia Medica, recommends the use of the agate as a preventive of contagion.

Alabaster.—According to Leonardus it is the best for vessels to hold unguents, which are preserved in them without spoiling. Dioscorides and many other doctors account it good in physics. He who carries it will prove victorious in suits at law.

Amber.—Supposed to be "generated out of the urine of the lynx, and is hardened by time; that voided by the male, brown; by the female, saffron, inclining to a darkness." Amber assuaged pain in the stomach, cured jaundice, flux, and king's evil.

It naturally restrains the flux of the belly; is an efficacious remedy for all disorders in the throat (a belief still prevalent). It is good against poison. If laid on the breast of a wife when she is asleep, it makes her confess all her evil deeds. Being taken inwardly it provokes urine, brings down the menses, and facilitated a birth. It fastens teeth that are loosen'd, and by the smoke of it poisonous insects are driven away. (Camillus Leonardus, Speculum Lapidum. 1502.)

When buried in a moist soil it was supposed to generate a fungus, which was administered to those troubled with the gravel. It cured fits, dysentery, scrofula, and jaundice. Used as an amulet it charmed away toothache, asthma, croup, and diseases of the throat; supposed to be efficacious as a curative and prophylactic if rubbed on the parts or taken internally, after dissolving in white wine. (Dissertatio medica de Succino, 1682.) These beliefs are still current.

Thomas Nicols writes that the—

white odoriferous amber is esteemed the best for physic use, and thought to be of great power and force against many diseases, as against the vertigo and asthmatic paroxysmes, against catharres and arthriticall pains, against diseases of the stomach, and to free it from sluffings and putrefactions, and against diseases of the heart, against plagues, venoms, and contagions. It is used either in powder, or in oil, or in troches, either in distempers of men or of women, either married or unmarried, either with child or without, or in the distempers of children. (Arcula Gemmea, 1653.)

Olaus Worm, of Copenhagen, writing in 1640, says that amber was received as a panacea; a sovereign remedy for toothache, asthma, and dropsy.

In the work "De Proprietatibus Rerum," by Bartholomaeus Glanvilla, amber is reported to possess the property of driving away adders and of being contrary to friends.

The Shah of Persia is said to wear an amulet of amber reported to have fallen from heaven, and which has the property of rendering him invulnerable. Amber is used to-day in Lombardy and the Piedmont as a cure for goiter—a belief that dates back to the time of Pliny.

Amethyst.—Emblematic of sincerity.

As an amulet it dispelled sleep, sharpened the intellect, prevented intoxication, gave victory to soldiers, and protected its wearer from sorcery. (Leonardus.)

"The amethyst banishes the desire for drink and promotes chastity." (Art Magic; or Mundane, Submundane, and Supermundane Spiritism.)

Lost its color in contact with and was an antidote for all poisons, (Albertus Magnus.)

According to Pliny, the amethyst was an antidote to drunkenness, and it takes its name from this property. Moreover, if the name of the moon or sun be engraved on it and it be thus hung about the neck from the hair of a baboon or the feathers of a swallow, it is a charm against witchcraft. It is also serviceable to persons having petitions to make to princes. With the assistance of a spell or incantation it kept off hailstorms and flights of locusts.

Porta, in his treatise on magic, says that the amethyst neutralizes magic incantations.

The Puranas hold that the amethyst "gives strength and cures morbid heat and fistula."

Beryl.—Used with incantations to foretell the future and review the past, was efficacious in detecting thieves, forewarned death, and was supposed to have power over and to be the abode of evil spirits that could be made to work the wearer's will by means of suitable notantations. It rendered its owner cheerful, preserved and increased conjugal love, cured diseases of the throat and jaws and disorders "proceeding" from the humidity of the head, and is a preservative against them." (Camillus Leonardus, Speculum Lapidum. 1502.)

According to Freeman, who wrote in 1701-

The beryl disturbs devils beyond all others. If it be thrown in water with the words of its charm sung it shews various images of devils and gives answers to those that question it. Being held in the mouth, a man may call a devil out of hell and receive satisfaction to such questions as he may ask.

Browning, in one of his poems, makes use of this belief.

The beryl was largely used for divination in 1600. The method was as follows: A bowl was filled with water and the ring suspended in it. The answer to the question propounded was spelled out by the ring striking the sides of the vessel. A modification of this, and one still in use, was to mark the edges of the bowl with the letters of the alphabet; the stopping of the ring at certain letters composed the answer. Still another method, and one said to have been used by Napier, was to throw a sphere cut from the stone into a bowl of water.

The character of the circles formed announced whether the presiding demon was favorable or not. If favorable, the information desired was pictured on the surface of the bowl.

Prior to the seventeenth century the beryl was in some repute as a curative. Mixed with an equal weight of silver, its powder, taken internally, was thought to cure leprosy. Water in which the stone had stood was good for the eyes, and, taken internally, it dispelled flatulency and cured indisposition of the liver.

Nicols, in the "Arcula Gemmea," published in 1653, said:

Wurtzung, in his general practice, saith that the beryll is used in all distempers of the heart. But take this caution by the way: Beware of the use of gemms (unless you are sure they be true) in physick, by reason they are so frequently adulterated.

Bloodstone.—Symbolical of wisdom, firmness, and courage.

Used with the proper incantations, its owner was enabled to foretell the future, and if rubbed with the juice of the heliotrope, it rendered its wearer invisible. The stone brought safety and long life to its possessor, stopped the flow of blood, and was an antidote for poisons. (Camillus Leonardus, Speculum Lapidum. 1502.)

Albertus Magnus taught that it cured dyspepsia, strengthened the stomach, and, if "washed according to medicinal art," was a styptic. Mixed with honey or the white of an egg, its powder was held by him to be an excellent remedy for hard tumors, while its dust would cure proud flesh and running sores.

Pliny and Leonardus mention that if placed in a basin of water containing the juice of the heliotrope and set in the sun, the water will appear red and the sun bloody. After a time the water will apparently boil and overflow the basin. Taken out of the water, the sun and solar eclipses could then be viewed in the water as in a mirror.

In a "Booke of the Thinges that are brought from the West Indies," published in 1574, the statement is made:

They doo bring from the New Spain a stone of great virtue, called the stone of the blood. The Bloodstone is a kind of jasper of divers colours, somewhat dark, full of sprinkles like to blood, being of colour red, of the which stones the Indians dooth make certayne Hartes, both great and small. The use thereof both there and here is for all fluxe of bloode, and of wounds. The stone must be wet in cold water, and the sick man must take him in his right hand and from time to time wet him in cold water. And as touching the Indians, they have it for certayne that touching the same stone in some part where the blood runneth, that it doth restrain.

The bishop of Rennes, in the eleventh century, writing on the talismanic efficacy of stones, asserts that the bloodstone endows its bearer with the gift of prophecy and renders him proof against poison.

During the Middle Ages the belief was prevalent in Europe that the stone had its origin in a dark-green jasper which happened to lie at the foot of the cross at the time of the crucifixion, and upon which the blood of Christ fell, hence the red spots.

Carnelian.—According to Epiphanius it cured tumors and all wounds made by iron.

It preserved the strength, prevented hoarseness, and cleared the voice. (Camillus Leonardus.)

It cheered the soul, banished fear and enchantments, and preserved harmony. (Albertus Magnus.)

According to the work by Giov. B. Porta, the wearing of a carnelian insured victory in all contests save those of love.

As an amulet and as a powder it was supposed to be a sovereign remedy for hemorrhage. De Laet, in 1647, has described from a personal experience its power in stopping bleeding at the nose, and advises the wearing of rings cut entirely from the stone for this purpose. The belief in its efficacy in such cases still persists.

Cat's-eye.—The cat's-eye cheers the mind, cures pallor, brings on a safe delivery in case of protracted labor, especially if tied in the hair of a patient. Applied locally, it causes infants suffering from the croup to bring up phlegm.

Applied as an ointment to the eyes, it cures lachryma. Calcined, the powder applied to sores heals them, and will cause new flesh to appear in the place of proud flesh. (Ben Adoula.)

According to the Mani-Mala, "the cat's-eye is warm, sour, and curative of cold, chronic derangements of the spleen, and colic, and is generally auspicious when worn." The same authority says that the perfect cat's-eyes, which are "heavy, deliciously cool, flawless, smooth, and otherwise faultless," are considered very lucky; while those that are defective bring about loss of friends, ruin, and wasting of the body.

The Hindus group the cat's-eye in four castes, according to their quality, all of which are replete with lucky signs.

The Persians held that the stone ground to a fine powder, mixed with water and then dried in the sun, and the operation repeated until the powder soaks up four times as much water as was first put in, would cure dropsy and inflammation of the navel if applied locally.

The Assyrians dedicated the stone to the god Belus, and ornaments containing it would, after the proper religious ceremony, render its wearer invisible to his enemies.

Chalcedony.—Prevented and cured melancholy. Worn as an amulet and in contact with the hairs of an ass, it was a preventive of danger during tempests and sinister events. (Camillus Leonardus, Speculum Lapidum. 1502.)

Reported to drive away evil spirits, a preventive of melancholy and sadness, and would bring victory to its wearer. (Andrea Baccius, Armot. Super. 6, c. de Natur. gem.)

Chrysoberyl.—As an amulet it dispelled evil dreams, fear, and melancholy; in addition, it possessed the properties of the beryl. (The Mirror of Stones. 1750.)

The oriental chrysolite (chrysoberyl) dispelled pestilential vapors and infectious airs. Taken internally, it alleviated asthma. (Rulandus, Medicina Practica. 1564.)

It was said to cool boiling water when immersed in it, soften anger, lose its luster on contact with poison, and induce its wearer to repent of the faults he had committed. (Porta, Magiae Naturalis. 1561.)

According to the Mani-Mala, the chrysoberyl, when set in gold and worn about the neck or hand, removes disease and vicious habits, and increases family, life, and happiness.

Chrysolite.—Cardanus, in his "De subtilitate," says that he cured one C. Palavicinus of a fever and another person of the "falling sickness" by the administration of powdered chrysolite with wine.

The powder was prescribed as a remedy for asthma. Held under the tongue, it assuaged thirst in fever. (Arcula Gemmea. 1653.)

Chrysoprase.—Preserved the sight, banished covetousness, and rendered its wearer cheerful. (Mirror of Stones. 1750.)

Worn as an amulet, it assuaged the pains of gout. (Arcula Gemmea. 1653.)

Bound around the arm, it was supposed to become a diuretic, to expel gravel, and prevent the generation of the stone. (Rulandus, Medicina Practica. 1564.)

Citrini.—The citrini (yellow corundum) protected the wearer from danger while traveling, secured him from pestilential vapors, and procured him every courtesy. (Arcula Gemmea. 1653.)

Coral.—In the "Arcula Gemmea" is a rather interesting account of the coral, as follows:

This is a but of maratime beauty, and the delight of children, the best of nature's buds, as somewhat furthering the springtide of their growth. The corall is a plant of nature's setting in the sea, which, though being covered with the waters of the sea, it bee green and soft, yet so soon as it is elevated above the waves and discovered in the region of the aire it altereth its colour and changeth its nature; its colour from green to a very noble and lbeautiful red; its softnesse into the compacted firmness and solidnesse of a stone, beautifull and lasting; by the operation of the aire encompassing its sometimes soft and flaccid substance. It is (under the waters of a brinish sea) a thriving, growing plant, sprung by nature with the ornament of many pretty branches, which is no sooner violently forc'd from the place of its growth and brought to light above the overflowing of the waters, but it blushes at the injurious hand that offereth violence to its secret, silent, tender, spreading growth.

Provid, the Roman poet, accounts for the origin of the coral in the "Metamorphoses" in the following manner:

Perseus, having cut off the head of the Medusa, placed it upon some twigs and leaves near the seashore. The twigs were turned to stone on contact with the head, were scattered far and wide beneath the sea by sea nymphs, and thus became the seeds of coral.

The coral was thought to be of greater beauty when worn by a man than by a woman. By its change of color it was thought to fore-

warn the approach of disease; and should the wearer become dangerously sick, the gem became spotted. Worn as an amulet, it drove away fear, kept men from the influence of sorcery and evil spirits. It was a protection against poison, plague, and storm. (Arcula Gemmea. 1653.)

It secured women from *incubus* and men *succubus* and hindered the delusions of the devil. (Dioscorides, De Materia Medica.)

Coral was administered, according to the following prescription, for vomiting, purging, and colic:

# Tabellae Corallatae.

B. Corrallorum rubeorum praeparatorum, 3ii; margaritar praeparator, 3i; boli armeni,  $3\beta$ ; light aloes,  $\Im$ i. Sacch. albissimi dissoluti in aqua rosaru cinnamomi tenuioris quantum sufficit; fiat confectio in tabellis. (Arcula Gemmea. 1653.)

According to the "Medicina Practica" of Rulandus, written in 1564, a half drachm of powdered coral was given as a cardiac stimulant; and in all contagious diseases, fevers, and poisonings the "tinctura corallorum" and the "sal corallorum" were equally efficacious.

Stopped every flux of blood; drove away ghosts, illusions, and dreams; was a protection against lightning, wind, tempest, and attacks of wild beasts. (Methrodorus.)

It gave relief to pains in the stomach and heart and strengthened those organs. It made sound diseased gums, and cleansed putrid sores. The powder, taken with wine, was given for the gravel. If hung on fruit-bearing trees, it insured fertility and protected them from hail and blighting winds. A kind known as *Grogius* had the power of stopping thunder and lightning. (Leonardus, Speculum Lapidum. 1502.)

Before the time of Pliny coral was held in great esteem, but during his period it was apparently not so highly appreciated, since he remarks "that formerly it was deemed a most excellent antidote for poison." During the Middle Ages, however, it was in great repute throughout Europe both as a drug and as an amulet. It was at that time deemed a powerful astringent, and in demand as a talisman against witchcraft, poison, epilepsy, etc.

Boetius de Boot, writing in 1636, says that he was cured of a dangerous pestilential fever by taking 6 drops of tincture of coral. A. de Villenevee prescribed 10 grains of coral for infants in order to preserve them from epilepsy or any other fit through life. It is still in repute as a preservative against children's diseases and is not infrequently worn suspended from the neck for this purpose. In India it is occasionally given to children in the hope of ridding them of the hives and kindred itches.

According to the Mani-Málá a deep red coral was worn as an immediate cure for poisoning. Kar, an oriental sage, says that any man who wears an ugly discolored and rough coral courts death.

Sanskrit medical science taught that coral is sour, sweet, a specific for cold and biliousness, nutritious, and grace imparting; and the wearing of it very beneficial to women.

According to the Arabic and Persian writers, as given by Tagore in his Treatise on Gems, a dose of coral was considered to be a good astringent, a remedy for all bleedings, and an antidote for all poisons. Worn over the parts it cured all stomach complaints; worn around the neck it stopped crying in infants and protected them from fear and sudden starts while asleep. In Afghanistan the coral mixed with gold dust is given as a tonic. In Egypt it is used according to the following receipt:

Cut open a lemon and put a piece of coral inside, cover the opening with a paste of clay, and place the whole under a fire for some time until it gets white from burning; remove it and after grinding the stone use it as an ointment for the eyes. Mixed with electuaries and taken internally it will give great physical strength.

Porta, in his Magiae Naturalis, says that the coral will arrest the flow of blood and keep off evil spirits. This belief still persists in Italy, where a hand holding a branch of coral is not infrequently worn as a protection against the evil eye.

Diamond.—This stone, being of all gems the purest, hardest, and most brilliant, was considered to be the most powerful in spiritual influences and was consecrated to all that was holy and heavenly. It was symbolical of constancy, purity, and innocence, and hence early used in betrothal rings. It softened anger, strengthened love, and was considered an infallible test of conjugal fidelity. To the ancients the diamond represented inexorable justice and unchangeable fate, hence the judges of Hades were described as having hearts and bosoms of adamant.

According to the Talmud, a certain gem, supposed to have been the diamond, worn in the girdle of the high priest, if brought in contact with an accused man became dark and dim if the suspect was guilty; if innocent the stone shown with increased brilliancy.

In Europe as late as 1700 the diamond was thought to be the most potent talisman against poison, pestilence, witchcraft, etc. It was esteemed a safeguard to virtue; was used as a preventive of and a cure for lunacy. It was supposed to drive away lemures, incubi, and kindred terrors; and was considered a preservative against lightning. The gem was supposed to possess sex, and Boetius de Boot mentions two such diamonds which by their union produced others and thus left a numerous progeny.

Sir John Mandeville also bears witness to the procreative powers of diamonds:

They grow together, male and female, and are nourished by the dew of heaven; and they engender commonly, and bring forth small children that multiply and grow



all the year. I have oftentimes tried the experiment, that if a man keep them with a little of the rock, and wet them with May dew often, they shall grow every year and the small will grow great.

Speaking further concerning the diamond, Mandeville held that in order to secure the greatest good from a diamond it should be worn on the left side:

For it is of greater virtue than on the right side; for the strength of their growing is toward the north, that is the left side of the world, and the left part of a man is when he turns his face toward the east. He who so carries the diamond upon him, it gives him hardness and manhood, and it keeps the limbs of his body whole. It gives him victory over his enemies, if his cause is just; and it keeps him that bears it in good wit; and it keeps him from strife and riot; from sorrows and enchantments; and from phantasies and illusions of wicked spirits. It makes a man stronger and firmer against his enemies; and heals him that is a lunatic, and those whom the fiend pursues or torments. And if venom or poison be brought in presence of the diamond, anon it begins to grow moist and sweat. Nevertheless, it happens often that the good diamond loses its virtue by sin, and for incontinence of him who bears it; and then it is needful to make it recover its virtue again, or else it is of little value.

Pierre de Boniface, a fourteenth century alchemist, taught that one of the virtues of the diamond was to render its wearer invisible and invincible.

In this connection the Shah of Persia is the possessor of a diamond set in a scimitar which is believed to render him invincible so long as he has it by him. The shah also has a five-pointed star of diamonds which is thought to make conspirators instantly confess their crimes when in its presence.

A diamond ring was given to Mary, Queen of Scots, by Ruthven, as a talisman against danger and poison. The queen also possessed two other diamonds—"one medicinable and against poison," the other "medicinable for the collicke."

According to the Puranas, the diamond varies in the preponderance of one or the other of the five primal elements—

Earth, water, sky, energy, and air. The "airy" sort gives heart and gracefulness, the "skyey" diamonds bring about the possession of all kinds of wealth. The ownership and use of those kinds in which energy predominates adds to puissance, herosem, and hope. Those diamonds which are white like the jessamine flower, white clouds, or the moon, and are possessed of six or eight corners, sharp ridged, that have originated from water, and that shine in the darkness, lead to the instant cure of snake bites, and prove efficacious in neutralizing the effects of other poisons, and prove a panacea as soon as worn.

Like men, diamonds are divided into castes—Brahmins, Vaisya, Kshatriyas, and Súdras. The wearing of superior Brahmin diamonds gives favor in the eyes of the gods. The better sort of the Kshatriya class bring about uniform success, accession of power, and destruction of foes. The best stones of the Vaisya class are productive of fame, wisdom, and skill in the fine arts. The higher order of the Súdra caste induce benevolence in their owner and make him hale and wealthy.

As the promiscuous intercourse of one caste with another gives rise to mixed castes among men, so it is with diamonds. These mixed castes give rise to impurities and flaws in the stones, and which, according to their nature and kind, are fraught with

grave trouble to man. Such diamonds cause unchastity; brings destruction; renders man apprehensive of snake bites; creates fear; leads to ruin, loss of family dignity, and death. Such stones are dangerous to pregnant women and contact with them may lead to abortion.

A shapeless diamond is fraught with danger; a dirty diamond with grief; a rough diamond with unhappiness, and a black diamond with various troubles. A three-cornered diamond gives rise to quarrels; a four-cornered diamond occasions various fears; a five-cornered one brings death; but a six-cornered stone is productive of good.

Since the use of impure diamonds leads to danger, causes swelling in wounds, faintness, leprosy, pleurisy, jaundice, etc., it is highly advisable to refine and purify the stone before using it medicinally.

The process is as follows: On some auspicious day dip the diamond in the juice of Kantakari (solarium jaquiri) and then burn it in a fire made of dried cow or buffalo dung. The burning should be carried on for a whole night. In the morning the diamond should be put under horse's urine and again burnt. These operations are continued for seven days. The stone is then immersed in a gruel made of various leguminous seeds to which assafoedita and rock salt have been added and heated repeatedly twenty and one times. By this means the diamond is purified and reduced to ashes. The taking of a diamond so treated gives longevity, strength, energy, beauty, develops the parts, and effects a cure for every distemper. (Mani-Málá.)

The Brahmin diamond is useful in chemical operations, and brings about the acquisition of power, friends, wealth, position, and good luck to one's family. A Kshatriya diamond wards off old age and premature death; a Vaisya one crowns every endeavor with success; while a Súdra one is a panacea.

The Hindu held that the diamond was masculine, feminine, or neuter according to its marking and appearance. The masculine kinds were considered the best and were useful in medicine. The feminine diamond was auspicious to women; but the neuter diamond was destructive of vigor and brought weakness and disappointment; as a medicine it was administered for impotency.

According to the views of Arabian and Persian authorities the diamond, if worn, imparted health and dispelled fear. Tied around the thighs of a woman about to be confined it brought on a safe and speedy delivery and assuaged the pain of labor. Cut into a hexagon and worn on the arm it cured epilepsy. Combined with other ingredients and used as a dentifrice it rendered the teeth bright and hard; its use in this manner was attended with risks, for on too long a contact with the teeth it caused them to fall out; while the presence of a single particle in the stomach was liable to produce death. It was a fatal poison if taken internally without electuaries; and—

if by accident one takes a quantity of it his life should not be considered safe until he is made to vomit it out by means of drinking a quantity of fresh cow's milk or some heated clarified butter, or by any other means, such as applying the fingers to the inside of the throat. The soup of some fatty flesh is then to be given to the patient to complete the recovery. (Tagore, Treatise on Gems.)

The Burmese call the diamond and arsenic by the same name, chein, on the ground that they are both fatal poisons.

This idea was not unknown in Europe, for we find the diamond listed as one of the poisons given to Sir Thomas Overbury when a prisoner in the Tower; while Benvenuto Cellini, the famous goldsmith, writing about 1560, relates how his life was preserved by the roguery of an apothecary, who, being employed to pulverize a diamond intended to be mixed in a salad for Cellini with the intention of poisoning him, substituted a beryl as cheaper, thus saving the life of Cellini.

According to Sanskrit medicine the diamond combined all the six tastes, cured every disease, brought health and strength, and was very useful in chemical operations. (Mani-Málá.)

In Egypt the diamond, when set in gold, gives health and wealth to its wearer.

According to Porta, in his Magiae Naturalis, the diamond contends against sleeplessness, enchantments, and turns away wrath.

Rabbi Benoni, a fourteenth century mystic, held that the diamond was capable of producing somnambulism, and when used as a talisman with lodestone and sapphire it would attract such powerful planetary influences as to render its wearer almost invincible.

In Art Magic; or Mundane, Submundane, and Supermundane Spiritism, it is stated that the diamond is the most powerful of all means to promote spiritual ecstacy.

Emerald.—Emblematic of happiness. As an amulet it was a preserver of chastity, and betrayed or punished its violation by flying into pieces or losing color. It preserved women in childbirth and eased the pains of labor; water in which the stone had stood hastened the afterbirth. (Leonardus.) Applied to the lips it stopped hemorrhage. When hung around the neck it prevented epileptic attacks. (Albertus Magnus.)

Dedicated to Mercury.

Much used by astrologers for the purpose of divination. (Cardanus, De Lapidibus Preciosis.)

Albertus Magnus cites the case of a certain King of Hungary who, while wearing an emerald, had knowledge of his wife, upon which the stone broke in three parts.

There is such an enmity betwixt it and illegitimate venery, or the uncleanness of the flesh, as that if it do but touch the skin of an adulterer it will break, and that it doth bridle the reins of lasciviousness and much temper it. (Arcula Gemmea.)

Avenzoar held that it was an antidote for poisons, and that 6 grains of its powder taken in water made an excellent cordial.

Mundella, a sixteenth century physician, calls attention to the purchase of a fine emerald by Franciscus Maria, Prince of Urbine, for use as a remedy in the treatment of a disorder with which he was troubled. (Arcula Gemmea.)

Ahmed Ben Abdalaziz, in his Treatise on Jewels, says that if a serpent fix his eyes on the luster of emeralds he immediately becomes blind. Thus Moore in "Lalla Rookh":

Blinded like serpents when they gaze Upon the emerald's virgin blaze.

The Shah of Persia has a small casket of gold studded with emeralds, said to have been blessed by Mahomet, which has the property of rendering the royal wearer invisible so long as he remains celibate.

The San Greal was a chalice made from a single emerald, and which possessed the power of preserving chastity, prolonging life, curing wounds and disease, and other wonderful properties. The Holy Grail was used at the Last Supper, and in it were caught the last drops of the blood of Christ as he was taken from the cross. In the legends and poetry of the Middle Ages are many notices of the Greal—a subject revived by Tennyson.

The Romans used it to rest, strengthen, and preserve the eyes, a practice which persisted through the Middle Ages, during which period water in which the stone had stood was used as a specific for ophthalmia.

Boetius de Boot gives directions for its treatment for use as a drug as follows:

Pound the emerald in an iron mortar, sift the powder through the muslin, then cover it with spiritos urinae; the spirit must be distilled off, leaving the powder of a gray color, but which will communicate that of the emerald to the spirits of wine.

This taken internally was considered a powerful remedy for many diseases, such as dysentery, epilepsy, venomous bites, fevers, etc. According to Sanskrit medicine—

The emerald is cool, good in poisoning, sweet, and purgative, helps digestion, cures biliousness, removes disrelish, is nutritious, and wards off spectral influences. (Tagore, Treatise on Gems.)

The Hindu authorities held that the perfect emerald was an infallible remedy for all cases of poisoning; cleansed men from sin, brought about success in war, and rendered successful the rites performed according to the Atharva-Veda. The defective emerald led to sickness, injury, loss of male children, and rendered one liable to bites. (Mani-Málá.)

The Persian and Arabian sages taught that, whether worn or taken as a medicine, the emerald—

bestows contentment of mind; quickens the pulse; gives nourishment to the soul, heart, brains, and stomach; cures epilepsy; removes all bodily pain; stops the vomiting and purging of blood; is an antidote to poison; allays unnatural thirst; and is a panacea for jaundice, liver troubles, stricture, gravel, and leprosy.

If administered in doses weighing 8 wheat corns to a patient suffering from poison, it neutralizes its action, provided it be taken soon enough. To prevent vomiting of blood, the dose of the emerald should be the weight of 4 barleycorns. The powder,

applied to the eyes, brings out all impurities therein and stops the flow of fluid substances. When set in a gold ring and worn on the forefinger or thumb it is prophylactic against cholera. The ashes of burnt emerald heals ulcers if applied locally.

According to the Rosicrucians, if at the time when Sol enters Libra an emerald be set in a gold ring of the same weight and worn on the finger, its wearer would attain his cherished object and could detect the presence of poisons by the sweating of the stone.

The possessor of an emerald would never become poor.

If a serpent looked at this stone, he was struck with blindness.

The Egyptians held that the best test for a genuine emerald was that a serpent immediately fell to licking it as soon as it came across it.

The Aztecs administered its powder as a remedy for venereal diseases.

Garnet.—Emblematic of constancy. Its virtue was to dispel "poisonous and infectious airs" (Leonardus). During the Middle Ages it was considered to possess the same marvelous and medicinal properties as the ruby, though to a less degree. It gave and preserved health, drove away vain thoughts, and reconciled differences between friends.

Suspended from the neck, it kept off plague and thunder, strengthened the heart, and increased riches and honors. (Giov. B. Porta, Magiae Naturalis. 1561.)

According to the Puranas-

A garnet which is colored like the conch. the lotus, the black bee, or the sun, and which is strung on a thread, is sound and auspicious, and heralds good fortune. A garnet which is colored like the crow, the horse, the ass, the jackal, the bull, or the blood-stained beak of a vulture holding a piece of flesh, brings on death.

Jacinth.—Procured sleep, riches, honor, and wisdom. A preservative against pestilence and foes. (Leonardus, Speculum Lapidum. 1502.)

Cardanus, in De Lapidibus preciosis, says that he was in the habit of carrying a jacinth about him for the purpose of inducing sleep, which he says "it did seem somewhat to confer, but not much."

Nicols, quoting Cardanus, says that jacinth procured sleep, cheered the heart, drove away plagues, brought protection from thunder, and increased wisdom and honor when worn on the finger or about the neck as an amulet. (Arcula Gemmea. 1653.)

Jade.—Worn as an amulet or administered internally, it was a curative of diseases of the kidney and loins.

Wecker, in the Antidotae speciale de Lapidibus minus preciosis Alterantibus, says that a nobleman, well known to him, had a fine "nephritick stone," which he wore on his arm—

by the power of which he voided a very great quantity of gravel, so great as that he feared lest he should suffer harm by so large an expulsion of it in so short a time.

Porta, in the Magiae Naturalis, says: It alleviates the pain of the kidneys, expels gravels from the bladder, and when worn as a charm is a preservative against venomous things.

Jasper.—Was a charm against scorpions and spiders. (Boot, Gemmarum et Lapidarum Historia. 1690.)

Checked the flow of blood; strengthened the chest, lungs, and stomach; cured fevers and dropsy; cleared the sight, and prevented conception. (Leonardus, Speculum Lapidum. 1502.)

In the list of valuables left by George, Earl Marischal, who died in 1620, is "ane jaspe stone for steming of bluid."

Mottled jasper, suitably engraved, was believed to prevent its wearer from death by drowning and to render him free from injury while on the water. (Arcula Gemmea. 1653.)

Burton, in the Anatomy of Melancholy, says:

If hung about the neck, or taken in drink, it much resisteth sorrow.

Nonus, a physician of the Middle Ages, reported of it that it cured epilepsy.

Galen asserted that a green jasper, worn as an amulet suspended from the neck so that it was above the navel, would cure dyspepsia and strengthen the stomach.

Jet.—Cardanus (De Subtilitate, lib. 5) says:

The wearing of this stone doth secure men from nocturnal fears, from incubus or succubus, or the nightmare, and from evil spirits; and that being drunk will show whether a maid hath her virginity or no.

Believed to dissolve spells and enchantments.

If burned as incense, its smoke drives away devils and relieves the dropsical. (Boetius, De Gagate.)

Bruised in water and given to a gravid animal, it brings forward the fetus. Its powder cures epilepsy and fastens loose teeth. Mixed with the marrow of a stag and taken internally it cures snake bites. (Speculum Lapidum. 1502.)

Used as a perfume it prevented irregularity in female periods. (Wurtz, Tab. gener. prac.)

Lapis-lazuli.—Believed to cure melancholia. (Speculum Lapidum.) Dioscorides, in De Materia Medica, suggests its use as a cure for melancholy, and states that it is a good purgative.

Cardanus advises its use in pectoral diseases of children and in epilepsy. The dose to be 5 grains. (De Subtilitate.)

Boetius (Tract. de Lapidibus et Gemmis) states that it is a good purgative. Unwashed, it purges by vomiting; washed, it purges by stool. Used for this purpose to-day in India, Chile, and Peru.

A. Mussa Brassavolus (Lib. de Med. purgant.) used it as a purgative according to the following prescription:

R. Lapidis lazuli praeparati, 3j. Camphorae, anisi, cinnamomi, zinziberis, mastiches ana, gr. 6. Misce, cum succo salviae vel diacatholico fiant pilulae quinq.

Dosis est à 3ij ad 3j, aut in pilulis, aut in pulvere, aut in jure, aut in aqua Boraginis, aut in conserva Boraginis, aut in vino cretico.

According to Sanskrit medical science lapis-lazuli is cooling and a curative of biliousness. (Mani-Málá.)

Lodestone.—Orpheus, in the Hymni et de Lapidibus, says:

It will confer strength, banish disease, and when worn constantly about the person ward off epidemics and plagues. Sitting before it and fixing the eyes earnestly upon it one has but to ask the gods for light on any subject, and the answer will come breathing out through the stone. The soul will hear it and the senses discover it clearly.

In great repute in Europe during the fifteenth, sixteenth, and seventeenth centuries for its numerous virtues as an amulet and drug. Carried about the person it cured cramp and gout; held in the hand during the hour of travail it shortened the time and eased the pains of labor. Bruised and taken internally with the juice of fennel it cured disorders of the spleen; applied as an ornament it prevented baldness. A dram of the stone mixed with the fat of a serpent and the juice of nettles caused insanity. The powder thrown over a household fire caused the inmates to flee in a panic, an artifice, according to the popular belief, made use of by thieves. (The Mirror of Stones. 1750.)

It is good against the headache, convulsions, and poisons; and that it causeth easy delivery, and procureth love 'twixt man and wife, and preserveth peace and concord amongst friends, and that it driveth away fears and increases wisdom. Galen and Dioscorides say it. (Arcula Gemmea. 1653.)

Lodestone is in repute to-day as a preventive and cure for cramps, colic, and rheumatism. Among the American negroes it is used as a voodoo stone, and is thought to be a love charm; to possess phallic properties; to increase the strength of the body, and to cure lumbago, rheumatism, and hernia.

Malachite.—Thought to increase the strength and growth of children and ward from them all dangers and infirmities. (Pliny, Nat. Hist.; Solinus, Polyhist., C. 36; Baccius de Nat. gem., C. 29.)

It strengthened the stomach; preserved children from hurt and convulsions. (Arcula Gemmea.)

Boetius states that 6 grains taken internally acts as an excellent purgative. It will cure "cardialgia" and colic. (Tract. de Lapidibus et Gemmis.)

Held to be a powerful local anaesthetic, for "being taken in drink or bruised in vinegar and applied to the members that are to be cut off and burnt, it makes them so insensible that they feel scarce any pain. (Speculum Lapidum.)

Moonstone.—According to Pliny, "the image of the moon contained therein daily waxes or wanes according to the period of the lunar motion."

During the period of the increase of the moon it was a potent love charm; during the period of decrease it enabled its wearer to fortell the future. Carried in the mouth it became an aid to the memory. As a powder and amulet it was prescribed in case of epilepsy. (Camillus Leonardus.) It is still used for this purpose among the Basques. (Crevecoeur.)

Onyx.—Its origin, according to the Greek legend, was due to Cupid cutting the nails of the sleeping Venus with his arrow; these falling into the Indus were changed to onyx.

The stone was thought to be a powerful aphrodisiac; to increase spittle in children; hasten a birth; give rise to nightmare, and stir up strife. Used as an eyestone "it enters of its own accord, and if it found anything within that is noxious, it drives it out and tempers the hurtful and contrary humors." (Camillus Leonardus, Speculum Lapidum. 1502.)

The belief in its causing nightmare and strife was widespread. This belief was explained by Beononi on the assumption that "in the onyx is a demon imprisoned in the stone who wakes only of a night, causing terror and disturbance to sleepers who wear it."

Among the Persians the onyx is to-day administered as a drug for the cure of epilepsy.

Opal.—Symbolical of hope.

The gem was in great repute as an eyestone, and was used in all diseases of the eye. It partook of all the virtues of those stones whose colors it showed. (Camillus Leonardus, Speculum Lapidum. 1502.)

It stimulated the heart; preserves from contagious and infectious airs; drives away dispondency; prevents fainting, heart disease, and malignant affections. (Giov. B. Porta, Magiae Naturalis. 1561.)

The opal was supposed to indicate the state of health of its wearer by change of color, losing its brilliancy if the wearer was ill, and the opposite.

The idea that the opal is unlucky is based on a Teutonic superstition, and is comparatively modern. Mention of its supposed evil qualities is made in a work entitled "Art Magic; Mundane, Submundane, and Supermundane Spiritism," in which the opal is credited with being fatal to love and sowing discord between giver and receiver.

Pearl.—Emblematic of purity, beauty, and nobility.

Pliny states that pearls were supposed to be generated by a celestial dew falling on the shellfish, which, in the early mornings of certain seasons, left the bottom of the sea to draw in the air containing the dew from which the pearls were derived, the size and quality of the pearl depending upon the size of the dewdrop and the purity of the air.

Cloudy weather spoiled the color, lightning stopped the growth, and thunder ruined the gem.

According to the ancient Hindu authorities pearls were held to originate in elephants, clouds, boars, conch shells, fishes, frogs, oysters, and bamboos. Of these the oysters were the most productive. The pearls were formed by raindrops falling into the open shell of the mollusk, the finest gems being found during the period when the sun rested on Arcturus, the fifteenth lunar asterism.

In the Orient the pearl was and is extensively used as a medicine for syncope, hemorrhage, stomach troubles, etc. In China large quantities of seed pearls are made into an electuary and taken to restore manly vigor and as a stimulant.

According to Sanskrit medical science the pearl is "sweet in taste, very cool, and a specific for eye diseases, cures poisoning and atrophy, and brings strength to weak limbs." (Mani-Málá.)

The Arabian and Persian sages held that the use of pearls was conducive to contentment of body and soul; cured insanity and all mental diseases; all diseases of the heart, stomach, and bowels; piles, stricture, and excessive and insufficient menstruation. It was an antidote for poison, stopped bleeding from cuts, and cured leprosy and skin diseases.

Rambam recommends the use of the burnt powder as an ointment in the treatment of ulcers and diseases of the eye, such an conjunctivitis, cataract, etc. The burnt powder taken internally cured vomiting of blood and purging.

According to Egyptian medicine, pearl powder taken with electuaries strengthened the body and added luster to the eyes.

The Hindu authorities recognized four shades as belonging to pearls—yellow, honey, white, and blue. The first brings wealth, the second fosters understanding, the third brings fame, and the fourth good luck. If defective, according to the kind and degree, the pearl brought on leprosy, loss of male issue, loss of fortune, disgrace, slothfulness, insanity, and death. (Mani-Málá.)

According to Art Magic; or Mundane, Submundane, and Supermundane Spiritism, the wearing of pearls brought one en rapport with spirits and promoted chastity.

In Bengal bracelets of pearl are worn by virgins to preserve their virtue.

In Europe as late as the seventeenth century decoctions containing pearls were thought to be powerful mental stimulants and a cure for insanity. A decoction of pearl powder and distilled water was one of the remedies given to the insane Charles, King of Spain.

Leonardus states that pearls boiled in meat would cure the quartan ague; powdered and taken with milk, they healed ulcers and cleared the voice; they comforted the heart, gave relief in cramps and colic,

cured epilepsy and dysentery; taken with sugar, they were of assistance in the cure of pestilential fevers, and that they rendered their wearers virtuous.

According to Nicols (Arcula Gemmea) pearls were—

good against syncopes, and cardiacall passions, that they do comfort the spirits, stop the fluxes of blood, cure lienteries and diarrheas, and that they are good for the sight.

Prase.—Supposed to possess all the properties of the emerald, but to a less degree. Lost its color on contact with poison or venom, but recovered it again on being washed. Reported to be an excellent cordial and cardiac stimulant. Applied to the eyes, it strengthened the sight. (Arcula Gemmea. 1653.)

Benoni states that the powder mixed with the milk of a ewe that has had but one lamb will, if applied locally, cure the gout; taken internally, it was a deadly poison.

Quartz.—The powder mixed with wine was given for dysentery in the north of England during the twelfth century. A crystal held against the tongue assuaged thirst. (Leonardus, Speculum Lapidum.)

Applied locally to-day in the mountains of Georgia for faintness, headaches, and bleeding at the nose. Used in parts of Virginia to cure styes; the sty is rubbed with the crystal three times a day for three days. In northern New York a so-called "vital ore," consisting entirely of quartz sand, is sold as a veritable panacea, curing sore eyes, piles, carbuncles, indigestion, sore throat, giddiness, and blood poisoning.

In the Middle Ages the clear, transparent quartz was believed to betray the presence of poison, either by becoming opaque or breaking. The powder, mixed with wine, was given in dysentery; held in the mouth, it assuaged thirst, cured headaches and faintness; powdered and taken with wine and honey, it filled the breasts of nursing women with milk. (Leonardus.)

Orpheus recommended its use as a medicine for diseases of the kidneys.

Andrea Bacci, writing in 1605, says:

It is used either in powder, or the salt of it, or the oil of it, against all obstructions of the bowels, against gouts, swoonings, and all cephalic diseases.

A drachm of the powder taken with oil of sweet almonds cures those that have taken sublimate. (Arcula Gemmea. 1653.)

Quartz balls were and are used by mystics, astrologers, and diviners to forestall the future, review the past, and conjure up distant scenes. The famous "show-stone" of Doctor Dee, a sphere 3 inches in diameter, was made of quartz. It is interesting to note that while the modern mystic and the mystic of the Middle Ages differ somewhat in their methods, each has the same end in view, and each has produced witnesses to show that he attained that end.

The methods used to induce a vision as practiced by the mystic of the Middle Ages are as follows: The crystal, according to Scot, in his Discovery of Witchcraft, when "charged" with the name of St. Helen, written on the stone with olive oil while the operator faced the east, and held in the hands of an innocent child born in wedlock, would, upon the recital of a prayer to the saint, become an oracle and answer any question put to it.

In an eighteenth century manuscript is the following statement:

Take a christall stone or glasse, most clear, without a craise, and wrape about it a pece of harte's lether, saying, "In the name of the Holy Trinity, and of the hey Deity Amen." Then holde the cristalle in the beam where the ③ is most bright, at the hotest of the day, and say there con(jurations) subscribed, and by and by you shall sie the spirit peradventer, appeiring himselfe.

The spirit is then to be "charged," upon which he will point out the whereabouts of stolen property; the location of buried treasure; give information concerning relatives, friends, or enemies, or such other information as may be desired.

According to Hindu authorities the quartz is cool and cooling, cures hemorrhage from the nose and mouth, and when worn removes baneful astral influences.

The crystal gives strength and cures biliousness, morbid heat, and fistula. A specific for consumption, leprosy, and poisoning. It may enter into medicines as a substitute for diamonds. (Mani-Mala.)

A good rock crystal is an infallible remedy in all cases of poisoning. Wild animals like the leopard, the elephant, the lion, and the tiger, can not approach this gem. It neutralizes snake, rat, and scorpion poisons, and the wearer need never fear drowning, fire, or a thief. A moss-colored, clouded, rough, yellow, dull, dirty, and discolored rock crystal the authorities shun from a distance. (Tagore, a Treatise on Gems.)

Ruby.—Emblematic of love.

A sovereign remedy and amulet against plague, poison, evil thoughts, nightmare, and diverted the mind from sadness and sensuality. (Leonardus, Speculum Lapidum.)

It forewarned the wearer of the approach of any misfortune by loss of color. In this connection Wolfgang Gabelchover gives his experience:

On December 5, 1600, as I was travelling from Studtgard in company with my beloved wife, Catherine Adelmann, of pious memory, I observed most distinctly during the journey that a very fine ruby, her gift, which I wore set in a ring upon my finger, had lost almost all its splendid color, and had put on dullness in place of brilliancy and darkness in place of light; which blackness and opacity lasted not for one or two days only, but for several. * * * Whereupon I warned my wife that some grievous mishap was impending over either her or myself, as I foreboded from the change of color in my ruby. Nor was I wrong in my anticipation, inasmuch as within a few days she was taken with a fatal sickness that never left her till the day of her death. And truly, after her decease, its former brilliant color returned spontaneously to my ruby.

Arabian and Persian writers taught that the wearer of the ruby obtained peace of mind and strength of brain.

A durm dose of it, taken internally, cures epilepsy, insanity, cholera, and the spitting of blood; causes free circulation of blood throughout the system, and prevents uneasiness of mind. It cures all kinds of poisonings from snake bite or from administration of poison by enemies. It frees the atmosphere from the pollution engendered by cholera. It purifies the blood and brings back to its normal state the fatally quick action of the pulse. The wearer of the ruby in the form of a finger ring obtains from the deity all the desires of his heart and becomes proof against thunder stroke and cholera. Worn over the eyes or applied to them as an ointment it cures all complaints of the vision; over the mouth it takes away the bad smell of it, allays thirst, and gives constant satisfaction to the mind. It brings honor to the wearer. The dose for internal use is from 1 kirat (4 barleycorns) to 1 dang (16 barleycorns). (See the work Karabadin Kabir, as cited by Tagore in his Treatise on Gems.)

The ruby enters into the Chinese pharmacopoeia as an ingredient in the "five precious fragments," supposed to consist of ruby, topaz, emerald, sapphire, and hyacinth.

The Hindu writers held that those rubies-

which are flawless and of approved color are auspicious, produce health, wealth, wisdom, and happiness. If flawed or offcolored they bring humiliation, loss of friends, liability to wounds, loss of wealth, and lightning stroke; are fatal to domestic animals, and are inimical to life, wealth, and fame. The man who treasures a ruby furnished with every perfection, and which when cast in a quantity of milk a hundred times its bulk, makes the white mass one entire sheet of red, or sends out a red flame, is as meritorious as the celebration of the Aswamedha jajna. Such a stone leads to wealth success, happiness, and long life. (Mani-Málá.)

Sapphire.—Emblematic of wisdom. If placed on the heart it bestows strength and energy. St. Jerome states that the sapphire procures royal favors, softens anger, frees people from enchantment, obtains release from captivity, and prevents evil and impure thoughts.

Because of its extreme coldness it was thought to preserve the chastity of its wearer, hence especially suited for ecclesiastical rings.

Worn in a ring or in any other manner it is able to quench concupiscence, and for this reason it is proper to be worn by the priesthood and by all persons vowed to perpetual chastity. It is said to grow dull if worn by an adulterous or lascivious person.

It rendered its wearer chaste, virtuous, pious, devout, wise, amiable, and pacific. It cured boils, carbuncles, and headaches, rested and refreshed the body, and gave a color to the cheeks. Taken with milk it cured cramps. (Leonardus, Speculum Lapidum. 1502.)

Soaked in vinegar its vinegar extract was administered in fevers; powdered and soaked in vinegar for one phase of the moon, it was given to insure continency and conjugal love. (Galen.)

¹ The Horse Sacrifice, a celebrated ceremony, the antiquity of which dates back to the Vedic period.



Placed on the heart it cured fever; on the forehead it stopped bleeding at the nose. The powder taken with milk was a remedy for fevers, plague, and poison. (Albertus Magnus.)

The powdered sapphire used as an ointment cured inflammation and irritation of the eyes; it was also thought to be able to draw out any foreign substance that might be present in them. (Canones Medicinae.)

According to Giov. Porta the sapphire was of great service in necromancy and the magic arts, and a deadly enemy to all venomous reptiles and insects. (Magiae Naturalis. 1561.)

The Hindus regarded the stone as unlucky and as a bringer of misfortune. Thus:

A sapphire, the surface of which wears a micalike sheen * * * brings about loss of wealth and life. That mark in a sapphire which at first sight looks like a rift, * * * renders one liable to bites. That sapphire which is parti-colored causes loss of family dignity. The sapphire which contains dirt produces a variety of skin diseases like itching. That which contains gritty fragments is destructive; that which is rough causes banishment. (Mani-Málá.)

The same authority says, however, "that sapphire which when placed in a pot of milk darkens it all through, increases wealth, and is conducive to fame and increase of family," while "a flawless, sterling sapphire brings its wearer strength, fame, and length of days," and "the man who wears a sapphire of spotless chastity finds favor with Narayana, and acquires longevity, family dignity, fame, understanding, and wealth."

According to the Sanskrit medical science the sapphire is bitter, warm, and good in cold and biliousness, and when worn alleviates the rage of Sani.²

In Egypt the sapphire is taken with majoom (electuaries) to add strength to the body. (Tagore, Treatise on Gems.)

The Buddhists esteem the sapphire above all gems, claiming that it produced tranquillity of mind, and when worn by one wholly pure and devoted to God insures protection against disease, danger, and venomous reptiles.

The saphire is of a cold and drie faculty, even as are most pretious stones; it is reported of it that it is good against feverish distempers, hence this old distick.

Corporis ardorem refrigerat interiorem Sapphirus, & cyprise languida vota facit.

The best of these are very comfortable to the eyes if they be often looked on. (Arcula Gemmea. 1653.)

It is reported of it that if it be worn by an adulterer, by loosing its splendor it will discover his adultery. (Cardanus, De Lapidibus preciosis.)

The sapphire is of so contrary a nature to poisons that if placed in a glass with a spider the insect will quickly die. (Arcula Gemmea. 1653.)

¹ The preserver of the Hindu Triad.

² One of the stars influencing the destinies of men.

St. Jerome wrote that the sapphire conciliates to its wearer the condescension of princes, quells his enemies, disperses sorcery, sets free the captive, and may even assuage the wrath of God.

In the inventory of the jewels of Charles V mention is made of a "bluestone with two clasps of gold, good for the gout."

In the church of Old St. Paul's, London, was a famous sapphire which was supposed to cure the infirmities of the eyes of all those thus afflicted who might resort to it.

The modern mystic holds it capable of attracting powerful planetary influences, and nearly equal to the diamond and quartz in inducing visions. (Art Magic; or Mundane, Submundane, and Supermundane Spiritism.)

The star sapphire was and is still reputed to be a potent love charm. The powder of this gem was taken as an aphrodisiac during the Middle Ages. Star sapphire as a powder was given for vertigo in the low countries as late as 1810.

Sard.—Said to possess sex.

The males shine brighter than the females; for the females are the fattest and glitter more obscurely. (Leonardus, Speculum Lapidum.)

The sard nullified the evil effects of the onyx when worn with it, sharpened the wit, gave cheerfulness, and prevented dysentery. (Albertus Magnus, Leonardus, and De Boot.)

Epiphanius, writing in 1565, says that the sard conferred upon its wearer a cheerful heart, courage, and presence, and protected him from witchcraft and noxious humors.

Baccius in his Annotations says that powdered sard taken in spirits stops the menses and prevents miscarriage.

Sardonyx.—Symbolical of conjugal bliss. It rendered its possessor virtuous, cheerful, and agreeable. (Leonardus, Speculum Lapidum. 1502.)

Spinel.—Reconciled differences between friends; gave health and strength to the body; cured disorders of the liver; restrained passion and fiery wrath; and was a preservative from lightning. (Leonardus.)

Powdered and taken with water Arnobis used it as a remedy for diseases of the eye. (Dissertatio Medica.)

Boetius held that the wearing of a balas ruby (spinel) restrained fury, wrath, and lust.

In the Arcula Gemmea, written in 1653, the author, Nicols, says:

Rulandus reporteth this of it: That if the four corners of a house, arbor, or vineyard be covered with this stone it will preserve it from lightning, tempests, and worms.

According to Arabian and Persian medicine, the wearing of the spinel gives contentment, prevents the spitting of blood, cures piles and all diseases caused by the increase of phlegm. The dose for

internal use is from 1 kirat (4 barleycorns) to 1 dang (16 barleycorns). Applied as an ointment to the eyes the stone adds to their luster.

According to an Arabic work, entitled "Azaabul beldan," as cited by Tagore:

The sea cows get spinel stones from the Kokaf Mountains and put them on the ground when they come grazing toward Ceylon. The stone gatherers, who remain concealed all about, then come out in stealthy steps, carefully throw lumps of clay over the stones left, and then retire. When after grazing these animals go back to the sea, disappointed at not finding the stones and fretting and fuming with rage, those people came back and took away the precious stones.

Staurolite.—In Brittany, France, a superstitious reverence is attached to the cruciform crystals of this stone, based on a belief that they fell from heaven.

In Virginia and the Carolinas the staurolite, locally known as fairy stone, is worn as a lucky charm and is believed to bring good fortune and ward off danger and disease.

Sunstone.—According to Sanskrit authorities—

the sunstone is warm, flawless, and good in cold and defective oxidation, and sacred; it is an elixir vitae, and is the delight of the Sun. (Mani-Málá.)

Topaz.—Symbolical of friendship.

It cooled boiling water on being immersed in it; became opaque on contact with poisons; restrained anger and desire; cured insanity; checked the flow of blood; cleansed hemorrhoids; and averted sudden death. (Camillus Leonardus, Speculum Lapidum.)

Benoni states that the topaz is favorable for all hemorrhages and imparts strength and good digestion. Powdered and taken in wine it cured asthma and insomnia. (Dissertatio Medica.)

Rubbed on a hone the topaz gave a milky juice in quantities, and yet lost none of its original weight. The juice was taken internally in cases of dropsy and certain poisonings. Used as an ointment it was in repute as a curative for diseases of the eye. (Epiphanius.)

Worn as an amulet, so says Porta, it drove away sadness and night-mare; strengthened the intellect and bestowed courage. Mounted in gold and hung around the neck it dispelled enchantments; worn on the left hand it preserved its wearer from sensuality.

In the Honest Jeweller, written in the seventeenth century, the statement is made that—

the virtue and strength of the topaz is said to increase and decrease with the moon, and consist in the fact that when thrown into boiling water it at once deprives it of its heat.

According to the Sanskrit authorities, the-

topaz is sour, cool, and curative of abnormal oxidation, gives an appetite, and brings fame and wisdom.

The Hindu sages held that the medicinal properties of the tops were similar to those of the coral, and in addition it prevented and cured sterility. (Mani-Mala.)

Like the ruby, the topaz was supposed to possess the power of emitting light to a great degree. A topaz given by the wife of Theodoric, count of Holland, to Adelbert, gave out so brilliant a light in the chapel where it was kept that prayers could be read by it.

Turquoise.—Emblematic of success. Highly valued by all orientals and worn by them to insure health and success. Supposed to preserve the wearer from injury through accidents. In the presence of poisons the stone sweated profusely, a property thought to be characteristic of many of the noble gems. Its color paled as its owner sickened and was lost entirely on his death, to be recovered only on its becoming the property of a healthy person.

The turquoise, according to Arabian and Persian authorities, as cited in the Mani-Málá, cured all diseases of the head and heart. A sovereign remedy for hernia, swellings, flatulence, dyspepsia, insanity, and cancerous sores. Whether taken alone, mixed with honey or with other drugs, it cures epilepsy, spleen, and stricture. In cases of poisoning or snake bite it was given with wine. Aristotle advises a similar dose for the same purpose. Applied as an ointment to the eyes it increased their luster, restored the vision, and prevented the fall of fluids therefrom. Worn as an amulet the turquoise brought happiness, dispelled fear, and rendered its wearer safe from drowning, lightning stroke, and snake bite. Seen after looking at the moon on the first day after the new moon it brought good luck.

In Egypt cure of a cataract is believed to be effected by the local application of a turquoise set in a silver ring and dipped in water, the application being accompanied by the chanting of the name of God.

Variolite.—Supposed to be a preventive and cure for variola (small-pox). (Castellani, History of Gems.)

Water sapphire or iolite.—A woman possessing a ring set with this stone as a signet, and on which was cut one-half of a fish, a mirror, a branch, and a nude female, procured any desire.

Zircon.—Supposed to bring riches, honor, and wisdom; a charm against plague and evil spirits; and afforded its wearer protection against thunderbolts. (Europe During the Middle Ages.)

According to the Mani-Mala-

The wearing of a weighty, lustrous, white, cool, tender, very old, and transparent gomeda (zircon) leads to prosperity. A light, discolored, exceedingly rough, delusion creating, and cool, yet dirty, gomeda blights happiness and saps the foundations of energy.

The same treatise, speaking of its medicinal value, says:

The zircon is sour, heating, and curative of unhealthy oxidation; sharpens the appetite, helps digestion, and takes away sin.

In conclusion, it would be expected to find the belief in the marvelous and medicinal properties of gems prevalent during the age of faith, while during the age of reason and inquiry it seems somewhat

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childish that they should still continue to exist. In India, the land of occultism, the mystics still pursue their researches after the occult virtues of precious stones. The modern Western spiritualist endeavors to discover and apply the occult knowledge of the East. He still believes in and teaches the virtues of gems, and is emphatic in his opinion that certain gems facilitate the rapport of a certain class of spirits with the wearers of those gems.

Swedenborg, the Swedish mystic, in his spirit revelations to L. A. Cahagnet, as cited in his Magic Magnetique (Paris, 1838), gives numerous categorical answers to questions asked by the medium concerning the spiritual and material powers of certain precious stones.

In Paris a school has been established which has for its object the study of the magnetic emanations, radiance, and crystals. In Nice a Doctor de Lignieres has issued a prospectus of a work of 644 pages that seriously considers the medicinal properties and virtues of precious stones.

## APPENDIX 4.

## GEM AND MINERAL NAMES.1

The following list of gem names has been compiled from the literature and from correspondence with the producers of precious stones in the United States. The list is in two parts. Part I gives the name of the gem followed by the name of the mineral species to which the gem belongs. Part II aims to give all the names of the mineral species followed by the names of the corresponding gems.

Many of the names have been coined by the dealers in particular minerals for the evident purpose of increasing their sales. Many people who buy cheap gem stones under fanciful names probably would not buy the stones if they were offered under their true mineralogic names. The list herewith will enable those who are interested to look up the true mineral species of the gems offered.

The use of the name of a valuable gem mineral combined with another modifying word instead of the true name of a mineral of less value—for example, "Alaska diamond" instead of quartz, or "Arizona ruby" instead of garnet—is incorrect and should be avoided. The list does not contain all the names applied to gem minerals. Such self-evident names as "milky opal" and "blue beryl" are omitted. The object of the list is to show the mineral species forming the gem and not to list all possible names which have been used for gems.

A few names of substances not minerals but commonly used as gems have been included. Artificial products, however, many of them made of glass and fraudulently sold under mineral names—for example, glass sold as "fire agate"—have been excluded.

### PART 1.-GEM NAMES.

A.

Achirite=dioptase from Siberia.

Achroite=colorless or white tourmaline.

Actinolite=green iron, calcium, and magnesium silicate (amphibole).

Adamantine spar=hair-brown corundum.

Adelaide ruby=blood-red pyrope (garnet) from South Africa.

Adularia=orthoclase (feldspar).

Aeroides=pale sky-blue beryl.

Agalmatolite=compact mica (aluminum and potassium hydrous silicate); also compact pyrophyllite (aluminum hydrous silicate).

Agate=variegated chalcedony.

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¹ From Mineral Resources of the United States for 1917, by Dr. W. T. Schaller, of the United States Geological Survey and formerly custodian of gems and precious stones in the United States National Musemum.

Agate jasper=intermediate between jasper and chalcedony with predominant translucent chalcedony; jasper with bands of chalcedony.

Agrite=brown, mottled, calcareous stone.

Alabandine ruby=red spinel of a violet tint.

Alabaster—white, fine-grained gypsum; also incorrectly applied to fine-grained and pure-white stalagmites of aragonite.

Alalite=diopside.

Alaska diamond=quartz.

Albite=aluminum and sodium silicate (feldspar).

Albite moonstone=iridescent albite.

Alençon diamond=quartz crystal from Alençon, France.

Aleppo stone=eye agate.

Alexandrite=emerald-green to dark-green chrysoberyl which changes in color to a columbine-red by artificial light.

Allanite=black hydrous aluminum, magnesium, cerium. and iron silicate and other elements.

Almandite (almandine)=columbine-red, or a deep crimson and violet garnet, aluminum and iron silicate.

Almandine spinel=violet-red spinel.

Alpine diamond=pyrite.

Amatrice=green, blue-green, and bluish variscite cut with its associated matrix.

Amazon stone=green microcline feldspar, aluminum and potassium silicate.

Amber=fossil resin.

Amber opal=opal colored brown by iron oxide.

Amberine=yellowish-green agate from the Death Valley region, California.

Ambroid=small pieces of inferior amber fused together.

American jade=californite (vesuvianite).

American ruby=blood-red garnet, mostly pyrope.

Amethiste basaltine=pale violet or reddish beryl.

Amethyst=purple and bluish-violet quartz, in crystals.

Amethystine quartz=quartz of an amethyst color, not necessarily in crystals.

Amphibole=group of minerals, aluminum, iron, calcium, magnesium silicates, and silicates of other elements.

Anatase=titanium oxide. Another name for octahedrite.

Ancona ruby=quartz.

Andalusite=aluminum silicate; also trade name for brown tourmaline.

Andesine=aluminum, sodium, and calcium silicate (feldspar).

Andradite=garnet, iron and calcium silicate.

Anthracite=hard iron-black coal, harder than jet or cannel coal.

Apatite=calcium phosphate, with fluorine.

Aphrizite=black tourmaline.

Apophyllite=calcium and potassium hydrous silicate.

Apricotine=yellowish-red quartz pebbles from vicinity of Cape May, New Jersey.

Aquamarine=light bluish-green or sea-green beryl.

Aquamarine chrysolite=greenish-yellow beryl.

Aquamarine topaz=greenish topaz.

Aragonite=calcium carbonate in orthorhombic crystals.

Arizona ruby=deep-red pyrope (garnet) from Arizona and Utah.

Arizona spinel=deep-red pyrope (garnet) from Arizona and Utah. Same as Arizona ruby.

Arkansas diamond = diamond from Arkansas; also quartz crystals from Arkansas.

Arkansite=brilliant iron-black, opaque brookite, oxide of titanium.

Armenian stone=(in part) lapis lazuli.

Arrow points—Indian arrowheads mostly made of quartz, more rarely of obsidian or other fine-grained rock.

Asparagus stone=pale-yellow apatite.

Asteria = asteriated sapphire; also any gem showing a six-ray star when cut cabochon.

Asteriated topaz=asteriated oriental topaz (yellow corundum).

Australian sapphire=deep inky blue sapphire (corundum).

Automolite=dark-green to nearly black zinc spinel.

Aventurine=opaque yellow, brown, or red massive quartz containing inclusions of minute scales of some other mineral, such as mica or iron oxide.

Aventurine feldspar=sunstone.

Axstone=nephrite.

Axinite=aluminum, calcium, iron, and manganese hydrous borosilicate.

Aztec stone=chalchihuitl.

Azure quartz=blue quartz.

Azure stone=lapis lazuli.

Azulite=pale-blue smithsonite.

Azurite=blue, copper hydrous carbonate.

Azurite malachite=azurmalachite.

Azurmalachite=combination of the copper carbonates azurite (blue) and malachite (green) from the copper mines of Arizona.

В.

Baffa diamond=quartz crystal.

Bahias=diamonds from Bahia, Brazil.

Balas ruby=rose-red or pink spinel.

Barite=barium sulphate.

Basanite=velvet black, flinty quartz.

Bastite=variety of bronzite.

Beckite=silicified coral shells or fossiliferous limestone replaced by silica.

Beekite=beckite.

Bemiscite=salmon-colored feldspar from Bemis, Maine.

Benitoite=blue barium and titanium silicate.

Beryl=aluminum and beryllium silicate with small amounts of other elements.

Beryllonite=beryllium and sodium phosphate.

Bishop's stone=amethyst.

Bixbite=red and rose-colored beryl from Utah.

Black amber=jet.

Black lava glass=obsidian.

Black opal=opal in a dark matrix; also opal with vivid colors.

Blood agate=flesh-red, pink, or salmon-colored agate from Utah.

Blood jasper=bloodstone.

Bloodstone=massive dark-green jasper (plasma) with red or blood-colored spots; also hematite (German usage).

Blue chrysoprase=chalcedony stained blue with chrysocolla.

Blue john=dark-blue fluorite, tinged with violet.

Blue malachite=azurite.

Blue moonstone=blue chalcedony from the Death Valley region, California.

Blue rock=lapis lazuli from California.

Blue white=diamond of highest grade.

Bobrowska garnet=grossularite (garnet).

Bohemian diamond=rock crystal (quartz).

Bohemian garnet=dark blood-red pyrope (garnet).

Bohemian topaz=yellow quartz.

Bohemian ruby=red or rose quartz.

Bonamite=translucent apple-green smithsonite from New Mexico.

Bone turquoise=teeth of fossil animals (mammoths, mastodons, etc.) stained blue by iron phosphate.

Bottle stone=moldavite.

Bowenite=unusually translucent serpentine of a cream color.

Brazilian aquamarine=greenish topaz.

Brazilian diamond=diamond from Brazil; also clear quartz from Brazil.

Brazilian emerald=green tourmaline.

Brazilian pebble=rock crystal (quartz).

Brazilian peridot=yellow-green tourmaline.

Brazilian ruby=rose-red or pink topaz, both naturally and artificially colored. Most of the pink or reddish topazes have been artificially colored by heating the dark-vellow ones.

Brazilian sapphire=light-blue or greenish topaz; also blue tourmaline.

Brazilian topaz=golden to reddish-yellow topaz; also smoky quartz artificially changed to yellow by heat.

Briançon diamond=quartz crystal from southeastern France, cut in Briançon.

Brighton emerald=green bottle glass purposely thrown on beach at Brighton, England. Brilliant=diamond.

Bristol diamond=quartz crystal from Cornwall, England.

Bronzite=magnesium and iron silicate; variety of enstatite.

Brookite=hair-brown, yellowish, reddish, or ruby-red, transparent to translucent titanium oxide, in orthorhombic crystals.

Brown coal—brown or brownish-black coal, often retaining the original wood texture. Brown jacinth—vesuvianite.

Brown spar=ankerite from Chester County, Pennsylvania.

Bull's-eye=labradorite with a dusky sheen.

Burma ruby=blood-red ruby (corundum).

Burmite=amber from Burma.

Burnt amethyst=purple amethyst changed to brownish-yellow by heat.

Burnt Brazilian topaz=burnt topaz.

Burnt topaz=yellow topaz from Brazil which has been changed to pink by heat.

Byssolite=fine greenish hair-like asbestos or actinolite, inclosed in quartz.

By-water=yellow-tinted diamond.

C.

Cabochon=any gem cut round, without facets.

Cacholong=opaque, procelain-like, milky-white opal.

Cacholong opal=feebly translucent common opal.

Caesium beryl=beryl containing several per cent of caesium, one of the rarer alkalies.

The beryl is generally colorless or pink.

Cairngorm=yellow to smoky-brown, gray, or black quartz.

Calamine=zinc hydrous silicate. In England calamine is called smithsonite.

Calcite=calcium carbonate in rhombohedral (hexagonal) crystals.

Calcomalachite=mixture of calcium carbonate and malachite, from Arizona.

California cat's-eye=compact serpentine, sufficiently fibrous to show a silky luster and to yield a cat's-eye effect when cut cabochon, from Tulare County, California.

California iris=kunzite (spodumene).

California jade=californite (vesuvianite).

California moonstone=white or gray chalcedony.

California onyx=dark-brown aragonite.

California ruby=garnet.

California tiger-eye=California cat's-eye.

Californite=compact, translucent, green vesuvianite.

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Callainite=translucent green aluminum hydrous phosphate (probably variscite).

Cameo=relief carving on a gem (the opposite of intaglio).

Canary=yellow diamond.

Canary beryl=greenish-yellow beryl.

Cancrinite=complex aluminum, calcium, and sodium hydrous silicate and the carbonate radicle.

Candle coal=cannel coal.

Cannel coal=dark grayish-black or brownish-black coal.

Cape chrysolite=green prehnite from South Africa.

Cape garnet=bright red-yellow almandite (garnet).

Cape May diamond=colorless and clear quartz crystal from Cape May, New Jersey.

Cape ruby=blood-red pyrope (garnet) from South Africa.

Cape=diamond having a yellowish tinge.

Carbonado=black diamond, not crystallized.

Carbuncle=clear deep-red almandite garnet; also any red, scarlet, or crimson garnet cut cabochon. The term is also improperly applied to any red stone especially if cut cabochon.

Carmazul=oxidized copper ore showing red, brown, blue, and green colors, from Lower California, Mexico; composed of jasper, chalcedony, quartz, hematite, chrysocolla, and malachite.

Carnelian=translucent red chalcedony.

Carnelian-onyx=agate with red and white bands.

Cassinite=pearly, bluish-green aventurine feldspar from Delaware County, Pennsylvania.

Cassiterite=tin oxide.

Cat sapphire=dark-blue sapphire.

Catalinite=beach pebbles from Santa Catalina Island, California.

Catalina sardonyx=catalinite.

Catlinite=compact red clay.

Cat's-eye=any mineral having a changeable luster or showing opalescence without play of colors; also true cat's-eye (chatoyant chrysoberyl); also chatoyant quartz.

Celestial stone=turquoise.

Celestial precious stone-olivine from meteorite.

Cer-agate=chrome-yellow agate from Brazil.

Ceylon cat's-eye=chrysoberyl cat's-eye.

Ceylon chrysolite=yellowish-green or greenish-yellow tourmaline.

Ceylon hyacinth=garnet.

Ceylon opal=moonstone.

Ceylon peridot=honey-yellow or yellowish-green tourmaline.

Ceylon ruby=ruby from Ceylon; also deep-red almandine garnet from Ceylon; also any pale or pink ruby.

Ceylon sapphire=pale-blue sapphire (corundum).

Ceylonese zircon=fire-red cloudy zircon.

Ceylonite=black spinel.

Chalcedony=compact silica, transparent or translucent, with a waxy luster.

Chalcedony onyx=agate with white and pale bands.

Chalcedonyx=chalcedony with alternating stripes of gray and white.

Chalchihuitl=supposed to have been applied to blue, gray, or green calamine from Mexico, also to turquoise, emerald, prase, green jasper, and jadeite.

Chalchuite=green turquoise.

Changeant=labradorite.

Chert=compact silica, includes flint, hornstone, and jasper.

Cheesy copper=azurite.

Chessylite=azurite.

Chesterlite=microcline feldspar from Chester County, Pennsylvania.

Chiastolite=variety of and alusite with crosslike marking.

Chinarump=petrified wood from Arizona.

Chlorastrolite=impure variety of prehnite or thomsonite.

Chloromelanite=dark-green to nearly black jadeite.

Chloropal=green opal from Silesia, Germany. Mineralogically, a hydrous iron silicate.

Chlorophane=variety of fluorite which phosphoresces with a greenish light on being slightly heated as by friction or by the heat of the hand.

Chlorospinel=green spinel.

Chlorutahlite=utahlite (compact variscite).

Chondrodite=silicate of magnesium and iron, with fluorine.

Chrome garnet=uvarovite (garnet).

Chromic iron=chromite.

Chromite=chromium and iron oxide.

Chrysoberyl=aluminum and beryllium oxide.

Chrysoberyllus=greenish-yellow, honey-yellow, or wine-yellow beryl.

Chrysocarmen=very similar to carmazul.

Chrysocolla=green to blue hydrous copper silicate.

Chrysolithus=pale yellowish-green beryl.

Chrysolite=olivine or peridot; also light-golden chrysoberyl (incorrect usage); also improperly applied to any light greenish-yellow to yellowish-green transparent gem.

Chrysoprase=apple-green, olive-green, or whitish-green, translucent chalcedony.

Cinnamon stone=essonite (garnet).

Citrine=golden-yellow quartz.

Cloudy chalcedony=chalcedony with dark cloudy spots in a light-gray transparent base.

Cobaltite=metallic cobalt and iron sulphide and arsenide.

Cobra stone=chlorophane.

Colophonite=brownish-black andradite (garnet), characterized by a resinous luster; iron and calcium silicate.

Colorado ruby=pyrope (garnet). Same as Arizona ruby.

Colorado topaz=topaz from Colorado; also citrine (yellow quartz).

Common opal=translucent, only slightly colored opal without fire or play of colors.

Comptonite=thomsonite.

Congo emerald=dioptase from the Congo, Africa.

Copper emerald=dioptase.

Copper-ore gem=mixture of various copper minerals, such as green malachite, green or blue chrysocolla, blue azurite, red cuprite.

Copper-pitch ore=compact black or dark-brown mixture of iron and copper oxides.

Coral=hard calcareous structure secreted in or by the tissues of various marine zoophytes. When fossilized, the calcareous matter is often replaced by silica (see beckite).

Coral agate=beckite (see coral).

Cordierite=aluminum, iron, and magnesium hydrous silicate.

Cornish diamond=quartz crystal from Cornwall, England.

Corundum=aluminum oxide.

Corundum cat's-eye=corundum with a bluish, reddish, or yellowish reflection of light of a lighter shade than the stone itself.

Cotterite=quartz having a metallic pearly luster.

Creoline=purplish epidotized trap rock from Massachusetts.

Creolite=banded jasper from Shasta County, California.

Crimson night stone=purple fluorite from Idaho.

Crispite=sagenite.

Crocidolite=fibrous hornblende of a bluish or greenish color, iron and magnesium hydrous silicate. The altered form consists of silica colored yellow and brown with oxide of iron and is called tiger-eye.

Cross stone=chiastolite (andalusite); also staurolite.

Crystal=colorless transparent quartz; also artificial flint glass.

Cupid's darts=quartz crystal with needle-like inclusions of goethite.

Cyanite=kyanite.

Cymophane=chrysoberyl having a bright spot of light which seems to float over the surface as the stone is moved.

Cyprine=sky-blue vesuvianite.

D.

Damourite=compact mica, a result of the alteration of some preexisting mineral. Danburite=calcium borosilicate.

Datolite=compact massive calcium hydroborosilicate.

Dauphine diamond=rock crystal (quartz).

Davidsonite=greenish-yellow beryl from vicinity of Aberdeen, Scotland.

Delawarite=aventurine feldspar from Delaware County, Pennsylvania.

Demantoid=olive-green, brown, blackish-green, or light-green grossularite (garnet) from the Ural Mountains. Russia.

Dendrite=having the form of a tree.

Dendritic agate=mocha stone and moss agate.

Diallage=foliated variety of diopside.

Diamond = carbon, in isometric crystals.

Diaspore=aluminum hydrous oxide.

Dichroite=cordierite.

Diopside=calcium and magnesium silicate (pyroxene).

Dioptase=green hydrous silicate of copper.

Disthene=kyanite.

Doublet=consists of a real gem cemented to a piece of glass cut and colored to imitate the real stone.

Dravite=brown tourmaline.

Drop of water=rounded (water-worn), colorless, and transparent pebble of topaz.

Dumortierite=blue or lavender aluminum hydroborosilicate.

Dysluite=yellow or grayish-brown spinel.

E.

Edisonite=mottled blue turquoise.

Egyptian jasper=banded yellow, red, brown, or black jasper.

Egyptian pebble=Egyptian jasper.

Elaeolite=aluminum, sodium, and potassium silicate. Same as nephelite.

Eldoradoite=iridescent quartz from Eldorado County, California.

Elie ruby=red pyrope (garnet) from Elie in Fifeshire, Scotland.

Emerald=green beryl; also improperly applied to any green stone.

Emerald copper=dioptase.

Emerald malachite=dioptase.

Emeraldine=chalcedony artificially colored green.

Emeralite=green and bluish-green tourmaline from San Diego County, California.

Emerandine=dioptase.

Enhydros=hollow nodules of chalcedony partly filled with water.

Enstatite=magnesium silicate.

Epidote=greenish hydrous aluminum, iron, and calcium silicate.

Essonite = vellow variety of grossularite (garnet).

Euclase=bluish or greenish hydrous aluminum and beryllium silicate.

Evening emerald=peridot.

Euxenite=complex mineral containing columbium, titanium, and yttrium, and other elements.

Eye agate=concentric rings of agate with a dark center; also thomsonite.

Eyestone=thomsonite.

F.

Fairy stone=twinned crystal of staurolite, forming a cross.

False amethyst=purple fluorite.

False chrysolite=moldavite.

False diamond=quartz crystal.

False emerald=green fluorite.

False hyacinth=garnet.

False lapis=agate or jasper artificially colored blue.

False lapis lazuli=lazulite.

False ruby=red fluorite.

False sapphire=blue fluorite.

False topaz=yellow quartz; also yellow fluorite.

Fancy=term applied to stones having value other than intrinsic value.

Fancy agates=agates showing delicate markings and intricate patterns.

Fancy stone=unusual stone.

Fashoda garnet=dark brownish-red pyrope (garnet).

Feldspar=group of minerals, including orthoclase, microcline, albite, oligoclase, andesine, labradorite, aluminum and potassium, sodium, or calcium silicates.

Feldspar sunstone=sunstone.

Female sapphire=light-colored sapphire.

Feminine=term applied to stones of a paler color than masculine ones.

Fergusonite=black mineral composed chiefly of yttrium columbate.

Figure stone=agalmatolite.

Fire marble=dark-brown shell marble with brilliant firelike internal reflections.

Fire opal=red or yellowish-red opal.

First bye=diamond with a faint greenish tint.

First water=pure and colorless diamond.

Fish-eye=moonstone.

Fish-eye stone=apophyllite.

Flash opal=opal in which the color shows as a single flash.

Flêches d'amour=sagenite (quartz).

Fleurus diamond=quartz crystal.

Flint=compact silica, opaque, and of dull colors.

Floating light=cymophane.

Flos ferri=aragonite in shapes resembling coral.

Flowers of iron=flos ferri (aragonite).

Flower stone=beach pebbles (chalcedony) with flower patterns.

Fluorspar=fluorite.

Fluorite=calcium fluoride.

Fool's gold=pyrite.

Fortification agate=agate with parallel zigzag lines.

Fossil coral=coral replaced by silica (beckite).

Fossil pineapple=opal pseudomorph after glauberite, from New South Wales.

Fossil turquoise=bone turquoise.

Fowlerite=variety of rhodonite containing zinc.

Franklinite=black iron, manganese, and zinc oxide.

Frost stone=translucent gray chalcedony with pure-white patches or tufts, like snow-flakes, scattered through it, from the Mojave desert, California.

Fuchsite=green muscovite (mica).

G.

Gadolinite=velvety-black yttrium, beryllium, iron silicate, and silicates of other elements.

Gahnite=green zinc spinel.

Garnet—group of silicate minerals. The species are: Almandite, aluminum and iron silicate; andradite, iron and calcium silicate; grossularite, aluminum and calcium silicate; pyrope, aluminum and magnesium silicate; spessartite, aluminum and manganese silicate; uvarovite, chromium and calcium silicate.

Garnierite=green nickel and magnesium hydrous silicate.

Gem=cut and polished precious stone.

Gemstone=gem.

Geneva ruby=synthetic ruby made in Geneva, Switzerland.

Geyserite=siliceous deposit from a geyser.

Gibraltar stone=banded, mottled, or clouded calcium carbonate.

Girasol=corundum cat's-eye with a bluish, reddish, or yellowish reflection of light, lighter in shade than the stone itself, which moves on the surface of the stone like the lines of a starstone; also opal (see girasol opal); also moonstone (feldspar).

Girasol opal=fire opal.

Glass—artificial noncrystallized substance composed of silica and several bases, notably an alkali and lead.

Glass agate=obsidian.

Goethite=iron hydrous oxide.

Golconda diamond = diamond obtained from the regions watered by Krishna and Godavari Rivers but polished in Golconda, India.

Gold=metallic element, often mounted as found, as a nugget.

Gold opal=opal which shows yellowish light over a large area.

Gold quartz=massive quartz inclosing gold.

Golden beryl=clear bright-vellow beryl.

Golden stone=greenish-yellow chrysolite (olivine).

Golden topaz=topaz of a golden-yellow color; also golden-yellow citrine (quartz).

Goldstone—aventurine. An imitation of goldstone consists of glass with included metal filings (fraudulently sold as fire agate).

Gooseberry stone=brownish-green grossularite (garnet).

Goshenite=colorless, white, or bluish beryl from Goshen, Massachusetts.

Goutte d'eau=colorless topaz.

Goutte de sang=blood-red spinel.

Graphic granite=pegmatite composed of quartz and feldspar so arranged as to simulate writing.

Green agate=zonochlorite.

Green garnet=any green garnet; also incorrectly applied to green enstatite from South Africa.

Green starstone=chlorastrolite.

Greenstone=zonochlorite; also chlorastrolite; also californite (vesuvianite).

Grossularite=pale-green or yellow garnet.

Guarnaccino=yellowish-red garnet. Same as vermeille.

Gypsum=calcium hydrous sulphate.

H.

Hair stone=quartz with inclusions of hairlike crystals or fibers of some other mineral. Same as sagenite.

Harlequin opal=opal in which the colors form a minute mosaic or are set in small squares.

Hatchet stone=nephrite.

Haüynite=complex aluminum, calcium, sodium, and potassium silicate with the sulphate radicle.

Hawk eye=quartz with inclusions of fine blue parallel fibers of crocidolite.

Heliodor=beryl from Rossing, Africa; contains a small amount of uranium and is weakly radioactive. By daylight gold-yellow, by artificial light a delicate bluegreen.

Heliolite=sunstone (feldspar).

Heliotrope=bloodstone (quartz).

Hematite=iron oxide, either black or red.

Hemimorphite=calamine (English usage).

Hercynite=black to dark-green spinel composed of aluminum and iron oxides.

Herkimer diamond=clear quartz crystal from Herkimer County, New York.

Hessonite=variety of grossularite (garnet).

Hetaerolite=brilliant-black radiated mineral composed of the zinc and manganese oxides.

Hiddenite=green or yellowish-green spodumene.

Horatio diamond=colorless quartz from Arkansas.

Hornblende=aluminum, iron, calcium, magnesium silicate, and other elements.

Hornstone=compact form of silica, like flint but more brittle.

Hot Springs diamond=quartz.

Howdenite=chiastolite with fernlike markings, from South Australia.

Hungarian cat's-eye=quartz cat's-eye.

Hyacinth=red zircon; also wrongly applied to essonite or other light-colored garnets, to yellowish-red spinel from Brazil, and to red iron-stained quartz.

Hyacinth of Compostella=quartz, with red hematite inclusions.

Hyacinthozontes=sapphire-blue beryl.

Hyalite=clear and colorless opal.

Hyalosiderite=rich olive-green olivine, containing much iron.

Hydrophane=opal which becomes transparent in water.

Hypersthene=magnesium and iron silicate, variety of enstatite.

I.

Iceland agate=obsidian.

Iceland spar=clear calcite.

Iceland agate lava=obsidian.

Ichthyophthalmite=apophyllite.

Idocrase=vesuvianite.

Ilmenite=black iron and titanium oxide.

Image stone=agalmatolite.

Imperial jade (Chinese)=green, aventurine quartz.

Imperial yu-stone=green aventurine quartz.

Ilvaite=iron and calcium hydrous silicate.

Inca stone=pyrite.

Indian agate=moss agate.

Indian topaz=saffron-yellow topaz; also yellow quartz.

Indicolite=blue tourmaline.

Iolanthite=jasper from Crooked River, Crook County, Oreg.

Iolite=cordierite.

Iridescent quartz=rock crystal (quartz) filled with fine cracks containing air films which reflect the colors of the rainbow.

Iris=iridescent quartz; also applied to other iridescent minerals. California iris is spodumene.

Irish diamond=quartz crystal from Ireland.

Iron glance=hematite.

Isle of Wight diamond=quartz crystal.

Isle Royal greenstone=chlorastrolite.

Isopyre=very impure opal.

Italian chrysolite=vesuvianite.

Iztac Chalchihuitl=white or green Mexican onyx.

J.

Jacinth=yellow zircon, also improperly applied to essonite and other yellowish garnets.

Jade=two minerals, nephrite and jadeite. True jade is nephrite; many other minerals are also called jade, such as pectolite, vesuvianite, garnet, bowenite, serpentine, plasma, prehnite, agalmatolite, sillimanite, and saussurite (a rock).

Jadeite=greenish aluminum and sodium silicate (pyroxene).

Jager=bluish-white diamond of modern cut. Originally referred to diamond from the Jagersfontein mine, South Africa.

Jargon=white or grayish-white zircon.

Jargoon=jargon.

Jasp agate=intermediate between jasper and chalcedony with predominant opaque jasper.

Jasper=massive quartz, impure and opaque, containing more iron oxide than agate.

Jasper opal=deeply colored opal with many included impurities.

Jasperine=banded and variously colored jasper.

Jet=pitch-black or velvet-black coal sufficiently hard and compact to receive a brilliant polish.

Job's tears=local name for peridot from Arizona and New Mexico; also hyalosiderite, a rich olive-green olivine.

K.

Kashmir sapphire=cornflower-blue corundum.

Keystoneite=blue chrysocolla or chalcedony colored by copper silicate.

Kidney stone=nephrite.

Killiecrankie diamond=limpid topaz from Tasmania.

King topaz=clear pink, orange, red, yellow, or flesh-colored corundum.

Kinradite=jasper with spherulites of quartz, from the region around San Francisco, California.

Kornerupine=aluminum and magnesium silicate.

Kunzite=transparent lilac spodumene.

Kyanite=aluminum silicate.

L.

Labrador feldspar=labradorite.

Labrador hornblende=hypersthene.

Labrador spar=labradorite.

Labrador stone=labradorite.

Labradorite=feldspar, aluminum, sodium, and calcium silicate.

Lake George diamond=clear quartz crystal from Herkimer, New York.

Lake Superior greenstone=chlorastrolite.

Lapis lazuli=rock composed essentially of the minerals lazurite, haüynite, scapolite, calcite, pyroxene, amphibole, mica, and feldspar.

Lava=volcanic rock.

Lavendine=amethyst (quartz).

Lazulite=blue aluminum, iron, and magnesium hydrous phosphate.

Lazurite=blue aluminum, calcium, and sodium silicate, with the sulphate radicle.

Lechosos opal=opal showing deep-green flashes of color or specked with green and carmine; also used for milky opal.

Leelite=deep flesh-red orthoclase, having a waxy luster.

Lennilite=greenish feldspar from Lenni Mills, Delaware County, Pennsylvania.

Leopardite=porphyry with black spots of manganese oxide.

Lepidolite=mica, hydrous aluminum, lithium, and potassium silicate, with fluorine. Leuco sapphire=white sapphire.

Lignite=brown coal showing the form and fiber of the original tree.

Lintonite=zeolite, probably thomsonite, with alternating bands of green and red.

Lithia emerald=green spodumene.

Lithoxyle=wood opal showing woody structure.

Lodestone=magnetite (iron oxide) which shows polarity.

Love arrows=sagenite (quartz).

Lucky stone=fairy stone (staurolite).

Lumachelle=fire marble.

Lydian stone=basanite (quartz).

Lynx sapphire=water sapphire (cordierite); also very dark-blue sapphire.

Lynx stone=cordierite.

М.

Macle=chiastolite.

Madeira topaz=citrine quartz.

Magic stone=hydrophane.

Magnetite=black magnetic iron oxide.

Mahogany ore=compact mixture of iron and copper oxides.

Malachite=green hydrous copper carbonate.

Malacolite=diopside.

Male sapphire = deep-colored sapphire.

Marble=recrystallized limestone or dolomite.

Marcasite=iron sulphide, in orthorhombic crystals. The same iron sulphide, in isometric crystals, is pyrite.

Marekanite=mottled brown and black obsidian.

Mariposite=green compact micaceous aluminum, magnesium, and potassium hydrous silicate.

Marmorosch diamond=quartz crystal from Marmaros Comitat, Hungary.

Masculine = term applied to stones of a deep and rich color.

Matara diamond=colorless or faintly smoky zircon from Ceylon; the pale-brown zircons are sometimes decolorized by heat.

Matrix = rock surrounding mineral.

Meerschaum=sepiolite.

Melanite=dull-black andradite (garnet).

Menaccanite=ilmenite.

Menilite=grayish-brown banded, sometimes concretionary, opal from vicinity of Paris, France.

Mesolite=zeolite similar to thomsonite in composition, aluminum, calcium, sodium, and potassium hydrous silicate.

Mexican onyx=banded, mottled, or clouded travertine.

Mica=group of silicate minerals, containing aluminum, and potassium, with water, and other elements.

Microcline=potash feldspar in triclinic crystals, aluminum and potassium silicate.

Microlite = essentially a calcium tantalate.

Mineral turquoise=true turquoise.

Mocha agate=translucent agate or chalcedony with brown, red, or black dendritic figures like trees or plants.

Mocha stone=chalcedony with brown, red, or black, treelike inclusions of manganess oxide.

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Mohave moonstone=translucent, lilac-tinted chalecedony from the Mohave Desert, California.

Moldavite=dark-green to black glass resembling obsidian.

Monazite=cerium phosphate and other rare-earth elements.

Money stone=local name in Pennsylvania for rutile.

Montana agate=moss agate from Montana.

Montana jet=obsidian, from Yellowstone Park.

Montana ruby=garnet.

Montana sapphire=corundum; generally applied to dark-blue or greenish-blue sapphire (compare river sapphire).

Mont Blanc ruby=quartz.

Moonstone—feldspar (usually oligoclase or the adularia variety of orthoclase) showing a pearly opalescence; also commonly but erroneously applied to some white or gray chalcedony and to satin spar (gypsum).

Mora diamond=probably quartz crystal.

Morganite=rose-colored beryl from Madagascar.

Moriah stone=granular and spotted verd antique (serpentine).

Morion=deep-black almost opaque smoky quartz.

Moroxite=deep-green or blue-green apatite.

Mosaic agate=brecciated Mexican onyx.

Moss agate=chalcedony with greenish mosslike or treelike inclusions.

Moss jasper=opaque and translucent chalcedony crowded full with mosslike markings.

Moss opal=milky opal with black mosslike dendritic inclusions.

Mother of emerald=prase (quartz).

Mother-of-opal=rock matrix containing minute disseminated specks of precious opal.

Mother-of-pearl=the hard iridescent internal layer of various shells.

Mountain mahogany=banded obsidian.

Muller's glass=hyalite.

Myrickite=agate or chalcedony containing bright-red inclusions of cinnabar, from the Death Valley region, California.

N.

Nacre=mother-of-pearl.

Natrolite=zeolite, aluminum and sodium hydrous silicate.

Needle stone=sagenite (quartz).

Nephelite=aluminum, sodium, and calcium silicate.

Nephrite=true jade, a tough compact fine-grained tremolite (white) or actinolite (green).

Nevada diamond=obsidian, artificially decolorized.

New rock=bone turquoise (in distinction from "old rock"=true turquoise).

New Zealand greenstone=serpentine, richly colored, from New Zealand; also jade or nephrite from New Zealand.

Nicolo=onyx with a black or brown base and a bluish-white thicker wavy, top layer.

Nigrine=dark-brown to black rutile with some iron.

Noble opal=precious opal.

Novaculite=fine-grained hard chalcedonic silica.

0.

Obsidian=a glassy form of lava.

Ocean spray=satin spar (gypsum).

Occidental agate=agate less perfect than oriental agate.

Occidental amethyst=true amethyst (quartz).

Occidental cat's-eye=quartz cat's-eye.

Occidental chalcedony=somewhat opaque chalcedony; more opaque than oriental chalcedony.

Occidental diamond=rock crystal (quartz).

Occidental topaz=yellow quartz.

Occidental turquoise=bone turquoise.

Octahedrite=titanium oxide in tetragonal crystals, with slightly different properties from rutile.

Odontolite=bone turquoise.

Oeil de boeuf=labradorite.

Old rock=turquoise from Persia.

Oligoclase=feldspar, aluminum, sodium, and potassium silicate.

Olivine = magnesium and iron silicate. The word olivine is used as a trade name for green garnet (demantoid from the Ural Mountains), and is also improperly applied to any green stone. The following distinctions are sometimes applied to the mineral olivine: Chrysolite, inclining to yellow; peridot, inclining to yellowish green; olivine, inclining to green.

Onegite=quartz with inclusions of hair-like crystals of goethite.

Onyx=banded chalcedony with alternating bands of cloudy milk-white and another color, usually black.

Oolite=concretionary massive limestone (calcium carbonate) made up of minute spherical grains.

Opal=amorphous massive form of hydrous silica.

Opal agate=banded opal having alternate layers of opal and agate.

Opal jasper=jasper opal.

Opal onyx=alternate layers of precious and of common opal.

Opalescent chrysolite=chrysoberyl.

Opaline=opal matrix.

Opaline feldspar=labradorite.

Ophiolite=serpentine.

Orange topaz=same as Spanish topaz, smoky quartz changed to yellow by heat.

Oregon jade=californite (vesuvianite).

Oriental=variety of corundum (not necessarily found in the Orient).

Oriental agate=finely marked and very translucent agate.

Oriental alabaster=travertine.

Oriental amethyst=purple corundum.

Oriental aquamarine=light-green corundum.

Oriental cat's-eye=chrysoberyl cat's-eye; also smoky corundum.

Oriental chalcedony=very translucent chalcedony (compare with occidental chalcedony).

Oriental chrysoberyl=yellowish-green corundum.

Oriental chrysolite=greenish-yellow corundum; also chrysoberyl.

Oriental emerald=green corundum.

Oriental garnet=almandine (garnet).

Oriental girasol=girasol (corundum).

Oriental hyacinth=rose-colored corundum.

Oriental hyacinth=aurora-red corundum.

Oriental jasper=bloodstone (quartz).

Oriental lapis=lapis lazuli.

Oriental moonstone = pearly corundum.

Oriental onyx=banded, mottled, or clouded travertine.

Oriental opal=Hungarian opal carried to the Orient by merchants and then shipped back to Europe.

Oriental peridot=green corundum.

Oriental sapphire=(in part) blue corundum.

Oriental smaragd=green corundum.

Oriental sunstone=girasol (corundum).

Qriental topaz=yellow corundum.

Oriental turquoise=turquoise.

Orthoclase=potash feldspar in monoclinic crystals, aluminum and potassium silicate.

Orthose=moonstone (feldspar).

Ouachita stone=novaculite (whetstone); quartz.

Ouvarovite=emerald-green garnet colored by chromium.

Ox-eye=labradorite (feldspar).

P.

Pagoda stone=agalmatolite.

Pagodite=agalmatolite.

Paphos diamond=quartz.

Parisite=cerium carbonate (and other rare elements), with fluorine.

Paste=artificial lead glass used to imitate gems.

Paulite=hyperstene.

Pealite=opal-like variety of geyserite (silica).

Pearl=lustrous calcareous concretion with animal membrane between successive layers, deposited in the shells of various mollusks. Not a mineral but an animal product.

Pearlite=a form of obsidian.

Pebble=rock crystal (quartz).

Pecos diamond=quartz from Pecos River, Texas.

Pectolite=calcium and sodium hydrous silicate.

Pegmatite=coarsely grained rock composed of quartz and feldspar.

Pelhamite=variety of serpentine.

Peliom=cordierite.

Pennsylvania diamond=iron pyrite.

Peridot of Ceylon=same as Ceylon peridot, honey-yellow tourmaline.

Peridot=olivine. (See Olivine.)

Peristerite=iridescent albite (feldspar).

Persian lapis=lapis lazuli.

Perthite=potash feldspar (orthoclase or microcline) with laminae of soda feldspar (albite).

Peruvian emerald=the best emeralds from Muzo, Colombia.

Petoskey agate=cemented portions of fossil coral (beckite).

Petrified honeycomb=beckite.

Petrified wood=wood replaced by silica.

Phenacite=silicate of beryllium.

Phenomenal gem=one which shows a play or change of color by artificial light, or shows a movable line of light.

I iedmontite=brownish-red variety of epidote.

Pin fire opal=opal in which the area of the individual colors is very small.

Pink topaz=topaz either naturally pink or artificially colored pink by heating the yellow or brown varieties.

Pink wollastonite=lilac-colored pyroxene (diopside) from the region of San Francisco, California.

Pipestone=catlinite (compact red clay).

Pisolite=concretionary massive limestone, similar to oolite but made up of larger spherical grains.

Pistacite=greenish epidote.

Pitch opal=brown opal with a pitchy luster.

Pitchstone=obsidian of a pitchy luster.

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Plasma—massive translucent quartz, dark grass-green in color, sometimes with white or yellow inclusions of celadonite or of delessite.

Pleonaste=black spinel.

Polycrase-black mineral similar in composition to euxenite.

Porcelain jasper = a naturally indurated clay.

Porphyry=rock, variegated in structure, with individual crystals much larger than the fine-grained matrix.

Potstone=soapstone (impure talc).

Prase—massive, translucent, and spotted quartz of a green to leek-green color caused by inclusions of minute crystals of actinolite or other minerals.

Prase opal=apple-green translucent opal.

Precious coral=red coral.

Precious opal-opal showing a play of colors.

Precious schorl=tourmaline.

Prehnite-greenish aluminum and calcium hydrous silicate.

Prismatic moonstone=clouded chalcedony (quartz) from Mohave Desert, California.

Prismatic quartz=cordierite.

Prosopite=aluminum and calcium hydrous fluoride.

Pseudochrysolite=moldavite.

Pseudodiamond=quartz crystal.

Pseudoemerald=malachite.

Pyrite=iron sulphide in isometric crystals.

Pyrope=blood-red garnet, aluminum and magnesium silicate.

Pyroxene=group of complex silicates of aluminum, iron, calcium, magnesium, and other elements.

Q.

Quartz=crystallized silica.

Quebec diamond=quartz crystal.

Quinzite=rose-colored common opal.

R.

Radio opal=opal of a smoky color caused by organic inclusions or impurities.

Radiumite=mixture of black pitchblende, yellow uranotile, and orange gummite.

Rainbow agate—agate which shows iridescence when cut across the concentric structure.

Rainbow quartz=iridescent quartz.

Rattle boxes=limonite geodes.

Realgar=orange arsenic sulphide.

Reconstructed gem=one artificially made by fusing and recrystallizing fragments of natural gems.

Red stone=ruby.

Resin opal=opal with a resinous luster.

Rhinestone=rock crystal (quartz).

Rhodochrosite=pink manganese carbonate.

Rhodolite=rose-colored garnet, between pyrope and almandite; aluminum, iron, and magnesium silicate; from Macon County, North Carolina.

Rhodonite=pink manganese silicate.

Riband agate=agate with parallel layers.

Riband jasper=jasper with differently colored alternating bands.

Ribbon agate=banded agate.

Ring agate-agate with differently colored bands arranged in concentric circles.

Ripe diamond = true diamond (see unripe diamond).

River agate=moss-agate pebbles found in brooks and streams.

River sapphire-light-colored sapphire from Montana.

Rock crystal=clear quartz crystal.

Rock ruby=red garnet (pyrope).

Rocky Mountain ruby=garnet.

Romansovite=brown grossularite (garnet), aluminum and calcium silicate.

Rosaline=thulite (pink zoisite).

Rose quartz=massive rose-red to pink quartz.

Rose topaz=pink topaz.

Roselite=pink garnet. Mineralogically a calcium and cobalt hydrous arsenate.

Royal topaz=blue topaz.

Rubasse=quartz artificially stained red.

Rubellite=pink and red tourmaline.

Rubicelle=yellow or orange-red spinel.

Rubino-di-rocca=red garnet having a tinge of violet.

Rubolite=red opal from Texas.

Ruby=red corundum.

Ruby spinel=deep-red spinel.

Ruin aragonite=brecciated Mexican onyx.

Rutile=titanium oxide.

S.

Sabalite=yellowish to greenish banded phosphatic material, similar to or inclosing variscite, from Utah.

Sacred turquoise=pale-blue smithsonite.

Sagenite=transparent quartz with inclusions of hairlike or needle-like crystals or fibers of some other mineral, generally rutile.

Samarskite=black mineral of complex composition, essentially a yttrium, uranium, and iron columbate.

Sandy sard=sard dotted with darker spots (quartz).

Saphir d'eau=water sapphire (blue cordierite).

Sapparé=transparent kyanite.

Sapphire=blue corundum. The name is also applied to colorless and colored (except red) corundum.

Sapphire quartz=blue quartz.

Sapphirine=blue chalcedony, blue quartz; also blue spinel; aluminum and magnesium silicate.

Sard=chalcedony of a rich brown color, with a reddish tint; brownish-red or dark-brown carnelian (sardoine).

Sardoine=brownish-red or dark-brown carnelian.

Sardonyx (sard-onyx)=white and brown banded chalcedony.

Satelite=serpentine cat's-eye.

Satin spar—finely fibrous gypsum having a pearly opalescence; also finely fibrous calcite having a silky luster; also finely fibrous aragonite having a silky luster.

Saussurite=greenish to white or gray rock composed chiefly of zoisite.

Saxon chrysolite=pale wine-yellow or greenish-yellow topaz tinged with green.

Saxon topaz=pale wine-yellow topaz; also citrine (quartz).

Scapolite=group of minerals composed of aluminum, calcium, and sodium silicates, with the chloride, carbonate, or sulphate radicles.

Scarab=precious stone inscribed with symbols, engraved like a beetle.

Schaumberg diamond=quartz crystal from Schaumberg, Hesse, Germany.

Schiller quartz=quartz cat's-eye.

Schiller spar=bastite (enstatite).

Schnecken topaz=Saxon topaz.

Schorl=black tourmaline.

Schorlomite=black garnet containing considerable titanium.

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Scoopstone = amber collected from seaweed.

Scotch topaz=smoky quartz.

Seastone=amber cast upon shore by sea.

Selenite=colorless, transparent gypsum.

Semicarnelian=yellow agate.

Semiopal=colorless to strongly colored somewhat opaque, common opal.

Semiturquoise=soft pale-blue turquoise.

Sepiolite=magnesium hydrous silicate.

Serpentine=magnesium hydrous silicate.

Serpentine cat's eye=serpentine showing when cut a changeable luster or opalescence without play of colors.

Siam=dark-red ruby.

Siam ruby=dark-red ruby from Siam; also red spinel.

Siberian amethyst=rich or dark-colored amethyst.

Siberian aquamarine=very light greenish-blue beryl.

Siberian chrysolite=demantoid (garnet).

Siberian ruby=red tourmaline.

Siberian topaz=very pale blue or bluish-white topaz.

Siberite=violet-red tourmaline.

Siderite=sapphirine (blue quartz). Mineralogically, an iron carbonate.

Siliceous malachite=green chrysocolla.

Silicified wood=wood replaced by silica.

Sinople=quartz having red hematite inclusions.

Slave's diamond=colorless topaz.

Smaragdite=green variety of amphibole, like actinolite; also applied to other green stones, as the emerald, fuchsite, etc.

Smaragdus=smaragdite.

Smithsonite=zinc carbonate. In England this zinc carbonate is called calamine.

Smoky quartz=quartz crystals of a smoky or brown color.

Smoky topaz=true topaz of a smoky color; also more commonly smoky quartz.

Sobrisky opal=opal from the Lead Pipe Spring district in the Death Valley region, California.

Sodalite=aluminum and sodium silicate, with chlorine, generally blue.

Soldier's stone=amethyst.

Spanish emerald=emerald of the finest quality (presumably from South America).

Spanish lazulite=cordierite.

Spanish topaz=smoky quartz changed to yellow by heat.

Specular iron ore=hematite.

Spessartite=yellow, brown, or red garnet, aluminum and manganese silicate.

Sphaerulite=variety of obsidian.

Sphalerite=zinc sulphide.

Sphene=titanite.

Spinel=group of minerals composed of aluminum, iron, chromium, magnesium, or zinc oxides. The name spinel is also applied to the species of this group which consists chiefly of aluminum and magnesium oxides.

Spinel ruby=red spinel.

Spinel sapphire=blue spinel.

Spodumene=aluminum and lithium silicate.

St. Stephen stone=translucent chalcedony with round blood-red spots through it.

Stalactite=calcium carbonate in pendent masses deposited in caverns by evaporating water.

Stalagmite=calcium carbonate deposited from evaporating water on the floors of caverns.

Star stone=starolite (quartz).

Star-ruby=ruby (corundum) showing a star of light.

Star sapphire=grayish-blue sapphire (corundum) showing a star of light.

Star topaz=asteriated oriental topaz (yellow corundum).

Starolite=asteriated quartz.

Staurolite=aluminum, iron, and magnesium hydrous silicate.

Steinheilite=cordierite.

Stibiotantalite=antimony tantalate.

Succinite=amber; also amber-colored grossularite (garnet).

Sulphur diamond=pyrite.

Sun opal=fire opal.

Sunstone=feldspar (usually oligoclase or labradorite) containing inclusions of minute scales of iron oxide.

Swiss lapis=agate or jasper artificially colored blue.

Synthetic gem=one artificially made from chemicals.

Syrian garnet=almandite (garnet) of a violet shade.

Т.

Tabasheer=amorphous opal-like silica deposited in the joints of bamboo.

Tauridan topaz=very pale blue topaz.

Taxoite=serpentine from Chester County, Pennsylvania.

Test stone=basanite (jasper).

Texas agate=agate jasper from Texas.

Thetis hairstone=transparent quartz with inclusions of hairlike crystals of green actinolite.

Thomsonite=zeolite, aluminum, calcium, and sodium hydrous silicate.

Thulite=rose-red zoisite.

Tiger-eye=yellow to brown, altered crocidolite.

Titanite=calcium and titanium silicate.

Toad's-eye tin=concentric cassiterite. Same as wood tin but on a smaller scale.

Topaz = aluminum silicate, with fluorine. Most of the ordinary topaz of commerce is "false topaz" or yellow to brown quartz. Much of the "yellow quartz" is smoky quartz artificially changed from brown to yellow by heat. The term topaz is also improperly applied to any yellow stone.

Topaz cat's-eye=yellow corundum showing an elongated or round patch of opalescent light.

Topazolite=colorless, yellowish, or greenish andradite (garnet).

Touchstone=basanite (jasper).

Tourmaline=group of closely related minerals which are complex hydroboro-silicates of aluminum and one or more other bases, such as iron, manganese, calcium, magnesium, sodium, or lithium.

Trainite=impure banded variscite.

Tree agate=mocha stone.

Tree stone=mocha agate.

Trenton diamond=quartz crystal from Herkimer County, New York.

Trilobite=fossil.

Triphane=yellow or greenish-yellow spodumene.

Troostite=pink to gray willemite containing some manganese.

Turquoise=aluminum and copper hydrous phosphate.

Turkis=turquoise.

Turtle back=chlorastrolite; also matrix turquoise; also matrix variscite.

U.

Unripe diamond=quartz.

Ural chrysoberyl=alexandrite.

Uralian emerald=Siberian demantoid (green garnet).

Utahlite=compact variscite.

Uvarovite=green garnet containing chromium.

V.

Vallum diamond=quartz crystals from the Tanjore district, Madras Presidency, India.

Variolite=dark-green orthoclase (feldspar) containing lighter-colored globular particles.

Variscite=green hydrous phosphate of aluminum.

Vegetable fossil=amber.

Verd antique=variegated serpentine.

Verdite=green rock, composed chiefly of fuchsite (green muscovite containing chromium) or talc.

Verdolite=talcose-dolomitic breccia rock from New Jersey.

Vermeille=orange-red almandite (garnet); also orange-red spinel.

Vermilion opal=milky opal impregnated with cinnabar.

Vermilite=vermilion opal.

Vesuvian gem=vesuvianite.

Vesuvianite=complex silicate, chiefly of aluminum and calcium.

Vinegar spinel=yellowish-red spinel.

Violane=dark violet-blue diopside (pyroxene), from Piedmont, Italy.

Violet stone = cordierite.

Violite=compact purple chalcedony from San Diego County, California.

Volcanic chrysolite=vesuvianite.

Volcanic glass=obsidian.

Vulpinite=anhydrite.

W.

Wabanite=banded cream to black and gray to purple chocolate-colored slate from Massachusetts.

Wardite=aluminum hydrous phosphate.

Water agate=shell of chalcedony containing bubble of water.

Water chrysolite=moldavite.

Water opal-moonstone (feldspar).

Water sapphire=true water sapphire is cordierite; also white topaz.

Water stone=hydrolite (opal).

Wax agate=yellow agate, with a pronounced waxy luster.

Wax opal=yellow opal with a waxy luster.

Wernerite=scapolite.

White carnelian=cloudy, milk-white, or very pale reddish or yellowish chalcedony. White emerald=caesium beryl.

White jade=white nephrite; also compact white garnet; also white californite (vesuvianite).

White sapphire=colorless corundum; also quartz.

White topaz=colorless topaz; also quartz.

Willemite=zinc silicate.

Williamsite=variety of serpentine of a rich blackish oil-green color.

Wiluite=green vesuvianite; also yellowish-green to greenish-white garnet.

Wilsonite=purlpish-red scapolite.

Wolf's eve=moonstone (feldspar).

Wolf's eye stone=crocidolite.

Wollastonite=calcium silicate.

Wood agate=wood petrified or replaced by agate.

Wood opal=wood silicified by opal.

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Wood stone=silicified wood.

Wood tin=cassiterite with a concentric structure.

World's eye=hydrophane (opal).

X.

Xanthite=dark yellowish-brown vesuvianite from Amity, New York.

Y.

Yogo sapphire—dark-blue corundrum from Yogo Gulch, Montana. Yu stone—jade.

 $\mathbf{Z}_{-}$ 

Zincite=zinc oxide, mostly red.

Zircon = zirconium silicate.

Zoisite-aluminum and calcium hydrous silicate.

Zonite=variously colored chert or jasper, from Arizona.

Zonochlorite=banded prehnite, similar to chlorastrolite.

### PART 2.-MINERAL NAMES.

Α.

Allanite.

Amphibole—actinolite, axstone, byssolite, crocidolite, hawk's-eye, hornblende, jade, kidney stone, nephrite, New Zealand greenstone, smaragdite, smaragdus, tremolite, wolf's-eye stone.

Anatase.

Andalusite=chiastolite, cross-stone, macle, howdenite.

Anhydrite=vulpinite.

Ankerite=brown spar.

Apatite=moroxite, asparagus stone.

Apophyllite=fisheye stone, ichthyophthalmite.

Aragonite—alabaster, California onyx, flos ferri, flowers of iron, Gibraltar stone, iztac chalchihuitl, Mexican onyx, mosaic agate, oriental alabaster, oriental onyx, ruin aragonite, satin spar, stalactite, stalagmite, verd antique. (See also calcite.)

Axinite.

Azurite=blue malachite, cheesy copper, cheesylite.

Azurmalachite.

В.

Barite.

Benitoite.

Beryl—aeroides, amethiste basaltine, aquamarine, aquamarine chrysolite, bixbite, caesium beryl, canary beryl, chalchihuitl, chrysoberyllus, chrysolithus, david-sonite, emerald, golden beryl, goshenite, heliodor, hyacinthozontes, morganite, Peruvian emerald, Siberian aquamarine, smaragdite, Spanish emerald, white emerald.

Beryllonite.

Bone turquoise=fossil turquoise, new rock, occidental turquoise, odontolite.

Brookite=arkansite.

C.

Calamine = Aztec stone, chalchihuitl, hemimorphite.

Calcite=agrite, calcomalachite, fire marble, Iceland spar, lumachelle, marble, Mexican onyx, onyx marble, Oriental alabaster, colite, pisolite, satin spar.

Cancrinite.

Cassiterite=toad's-eye tin, wood tin.

Chondrodite.

Chromite=chromic iron.

Chrysoberyl=alexandrite, cat's-eye, Ceylon cat's-eye, chrysolite, cymophane, floating light, opalescent chrysolite, oriental cat's-eye, Ural chrysoberyl.

Chrysocolla=keystonite, siliceous malachite.

Clay=catlinite, pipestone, porcelain jasper.

Coal=anthracite, black amber, brown coal, candle coal, cannel coal, jet, lignite. Cobaltite.

Copper ore gem=carmazul, chrysocarmen, copper pitch ore, mahogany ore.

Cordierite=dichroite, iolite, lynx-stone, peliom, prismatic quartz, saphir d'eau,

Spanish lazulite, steinheilite, violet stone, water sapphire.

Corundum—adamantine spar, asteria, asteriated topaz, Australian sapphire, Burma ruby, cat sapphire, Ceylon ruby, corundum cat's-eye, female sapphire, girasol, Kashmir sapphire, king topaz, leuco-sapphire, lynx sapphire, male sapphire, Montana sapphire, oriental, oriental amethyst, oriental aquamarine, oriental cat's-eye, oriental chrysoberyl, oriental chrysolite, oriental emerald, oriental girasol, oriental hyacinth, oriental moonstone, oriental peridot, oriental sapphire, oriental smaragd, oriental sunstone, oriental topaz, red stone, river sapphire, ruby, sapphire, star ruby, star sapphire, Siam, star topaz, topaz cat's-eye, white sapphire, Yogo sapphire.

D.

Danburite.

Datolite.

Diamond=Bahia, blue-white, brilliant, by-water, canary, cape, carbonado, first bye, first water, Golconda, jager, ripe-diamond.

Diaspore.

Dioptase=achirite, Congo emerald, copper emerald, emerald copper, emerald malachite, emerandine.

Dumortierite.

E.

Epidote=piedmontite, pistacite.

Enclase

Euxenite.

F.

Feldspar=adularia, albite, albite moonstone, amazonstone, andesine, aventurine feldspar, bemiscite, bull's-eye, cassinite, Ceylon opal, changeant, chesterlite, delawarite, fisheye, girasol, heliolite, Labrador spar, Labrador stone, labradorite, leelite, lennilite, microcline, moonstone, oeil de boeuf, oligoclase, opaline feldspar, orthoclase, orthose, ox-eye, peristerite, perthite, sunstone, variolite, water opal, wolf's eye.

Fergusonite.

Fluorite=blue john, chlorophane, cobra stone, crimson night stone, false amethyst, false emerald, false ruby, false sapphire, false topaz, fluorspar.

Fossil=beckite, beekite, fossil coral, Petoskey agate, petrified honeycomb, trilobite. Franklinite.

G.

Gadolinite.

Garnet—Adelaide ruby, almandite, American ruby, andradite, Arizona ruby, Arizona spinel, Bobrowska garnet, Bohemian diamond, Bohemian garnet, California ruby, Cape ruby, carbuncle, Ceylon hyacinth, Ceylon ruby, chloromelanite, chrome garnet, cinnamon stone, colophonite, Colorado ruby, demantoid, Elie ruby, essonite, false hyacinth, Fashoda garnet, gooseberry stone, grossularite, guarnaccino, hessonite, hyacinth, jacinth, jade, melanite, Montana ruby, olivine, oriental garnet, ouvarovite, pyrope, rhodolite, rock ruby, Rocky Mountain ruby, roman-

sovite, roselite, rubino-di-rocca, schorlomite, Siberianchrys olite, spessartite, succinite, Syrian garnet, topazolite, Uralian emerald, uvarovite, vermeille, white jade, wiluite.

Garnierite.

Goethite.

Gold.

Gypsum=alabaster, moonstone, ocean spray, satin spar, selenite.

H.

Haüynite.

Hematite=bloodstone, iron glance, specular iron ore.

Hetaerolite.

T.

Ilmenite=menaccanite.

Ilvaite.

ĸ.

Kornerupine.

Kyanite=cyanite, disthene, sapparé.

T.

Lapis lazuli—Armenian stone, azure stone, blue rock, oriental lapis, Persian lapis. Lazulite—false lapis lazuli.

Lazurite.

Limonite=rattlebox.

М.

Magnetite=lodestone.

Malachite=pseudo-emerald.

Marcasite.

Mesolite.

Mica=agalmatolite, damourite, figure stone, fuchsite, image stone, lepidolite, mariposite, pagoda stone, pagodite, smaragdite, verdite.

Microlite.

Moldavite=bottle stone, false chrysolite, pseudo-chrysolite, water chrysolite.

Monazite.

N.

Natrolite.

Nephelite.

0.

Obsidian=arrow points, black lava glass, glass agate, Iceland agate, Iceland agate lava, marekanite, Montana jet, mountain mahogany, Nevada diamond, pearlite, pitchstone, sphaerulite, volcanic glass.

Octahedrite=anatase.

Olivine=celestial precious stone, chrysolite, evening emerald, golden stone, hyalosiderite, Job's-tears, peridot.

Opal—amber opal, black opal, cacholong opal, common opal, fire opal, flash opal, flash fire opal, fossil pineapple, girasol opal, gold opal, harlequin opal, hyalite, hydrophane, isopyre, jasper opal, lechosos opal, lithoxyle, magic stone, menilite, moss opal, mother-of-opal, Muller's glass, noble opal, opal agate, opal jasper, opal onyx, opaline, oriental opal, pealite, pin fire opal, pitch opal, prase opal, precious opal, quinzite, radio opal, resin opal, rubolite, semiopal, Sobrisky opal, sun opal, tabasheer, vermilion opal, vermilite, water stone, wax opal, wood opal, world's eye.

P.

Parisite.

Pectolite=jade.

Phenacite.

Pitchblende=radiumite.

Polycrase.

Prehnite—Cape chrysolite, chlorastrolite, green agate, green star stone, greenstone, Isle Royal greenstone, Lake Superior greenstone, turtleback, zonochlorite. (See also thomsonite.)

Procopite.

Pyrite=alpine diamond, fool's gold, Inca stone, Pennsylvania diamond, sulphur diamond.

Pyrophyllite=agalmatolite.

Pyroxene—alalite, bastite, bronzite, chalchihuitl (jadeite), diopside, enstatite, green garnet (enstatite), hypersthene, jade, jadeite, Labrador hornblende, malacolite, New Zealand greenstone, paulite, pink wollastonite, Schillerspar, violane, yu stone.

Q.

Quartz=agate, agate jasper, Alaska diamond, Alençon diamond, Aleppo stone, amberine, amethyst, amethystine quartz, Ancona ruby, apricotine, Arkansas diamond, arrow points, aventurine, azure quartz, Baffa diamond, basanite, beckite, beekite, bishop's stone, bloodstone, blood jasper, blue chrysoprase, blue moonstone, Bohemian diamond, Bohemian topaz, Bohemian ruby, Brazilian diamond, Brazilian pebble, Brazilian topaz, Briançon diamond, Bristol diamond, burnt amethyst, cacholong, cairngorm, California moonstone, Cape May diamond, carnelian, carnelian-onyx, catalinite, Catalina sardonyx, cat's-eye, cer-agate, chalchihuitl, chalcedony, chalcedony onyx, chalcedonyx, chert, china, rump, chloropal, chrysoprase, Colorado topaz, Cornish diamond, cotterite, creolite, crispite, crystal, cupid's darts, Dauphiné diamond, dendritic agate, Egyptian jasper, Egyptian pebble, eldoradoite, emeraldine, enhydros, eye agate, false diamond, false lapis, false topaz, fancy agate, feminine carnelian, flêches d'amour, Fleurus diamond, flint, flower stone, fortification agate, fossil coral, frost stone, geyserite, gold quartz, golden topaz, hairstone, heliotrope, Herkimer diamond, Horatio diamond, hornstone, Hot Springs diamond, hyacinth, Hungarian cat's-eye, hyacinth of Compostella, Imperial jade, Imperial yu stone, Indian agate, Indian topaz, iolanthite, iridescent quartz, iris, Irish diamond, Isle of Wight diamond, jasp-agate, jasper, jasperine, kinradite, Lake George diamond, lavendine, love arrows, lydian stone, Madeira topaz, Marmorosch diamond, masculine carnelian, milky quartz, mocha stone, Mohave moonstone, Montana agate, Mont Blanc ruby, moonstone, Mora dismond, morion, moss agate, moss jasper, mother of emerald, myrickite, needlestone, nicolo, novaculite, occidental agate, occidental amethyst, occidental cat'seye, occidental chalcedony, occidental diamond, occidental topaz, onegite, onyx, orange topaz, oriental agate, oriental chalcedony, oriental jasper, ouachita stone, Paphos diamond, pebble, Pecos diamond, petrified wood, plasma, prase, prismatic moonstone, pseudo diamond, Quebec diamond, rainbow agate, rainbow quartz, rhinestone, riband agate, riband jasper, ribbon agate, ring agate, river agate, rock crystal, rose quartz, rubasse, sagenite, sandy sard, sapphire quartz, sapphirine, sard, sardoine, sardonyx, Saxon topaz, Schaumberg diamond, Schiller quartz, Scotch topaz, semicarnelian, Siberian amethyst, siderite, sinople, silicified wood, smoky quartz, smoky topaz, soldier's stone, Spanish topaz, St. Stephen stone, star stone, starolite, Swiss lapis, test stone, Texas agate, Thetis hairstone, tiger-eye, topaz, touchstone, tree agate, tree stone, Trenton diamond, unripe diamond, Vallum dismond, Venus hairstone, violite, water agate, wax agate, white carnelian, white sapphire, white topaz, wood agate, woodstone, zonite.

R.

Realgar.
Rhodochrosite.
Rhodonite=fowlerite.

Rock—agrite, catlinite, clay, creoline, graphic granite, lapis lazuli, lava, leopardite, matrix, mother-of-opal, novaculite, obsidian, pegmatite, pipestone, porcelain-jasper, porphyry, potstone, saussurite (jade), verdolite, volcanic lava, wabanite. Rutile—money stone, nigrine.

S.

Samarskite.

Sapphirine.

Scapolite=wernerite; wilsonite.

Sepiolite=meerschaum.

Serpentine—bowenite, California cat's-eye, California tiger-eye, jade, moriah stone, New Zealand greenstone, ophiolite, pelhamite, satelite, serpentine cat's-eye, taxoite, verd antique, williamsite.

Sillimanite=jade.

Smithsonite=azulite, bonamite, sacred turquoise.

Sodalite.

Sphalerite.

Spinel=Alabandine ruby, almandine spinel, automolite, balas ruby, ceylonite, chlorospinel, chromite, dysluite, franklinite, gahnite, goutte de sang, hercynite, hyacinth, magnetite, pleonaste, rubicelle, ruby spinel, sapphirine, Siam ruby, spinel ruby, spinel sapphire, vermeille, vinegar spinel.

Spodumene=California iris, hiddenite, kunzite, lithia emerald, triphane.

Staurolite=cross stone, fairy stone, lucky stone.

Stibiotantalite.

Т.

Talc=verdite.

Thomsonite=comptonite, eye agate, eyestone, lintonite.

Titanite=sphene.

Topaz=aquamarine topaz, Brazilian aquamarine, Brazilian ruby, Brazilian sapphire, Brazilian topaz, burnt Brazilian topaz, burnt topaz, drop of water, golden topaz, goutte d'eau, Indian topaz, Killiecrankie diamond, pink topaz, royal topaz, Saxon chrysolite, Saxon topaz, Schnecken topaz, Siberian topaz, slave's diamond, tauridian topaz, water sapphire.

Tourmaline=achroite, andalusite, aphrizite, Brazilian emerald, Brazilian peridot, Brazilian sapphire, Ceylon chrysolite, Ceylon peridot, dravite, emeralite, indicolite, peridot of Ceylon, precious schorl, rubellite schorl, Siberian ruby, siberite.

Turquoise=celestial stone, chalchihuitl, chalchuite, edisonite, mineral turquoise, old rock stone, oriental turquoise, semiturquoise, turkis, turtleback.

V.

Variscite=amatrice, callainite, chlorutahlite, sabalite, trainite, turtleback, utahlite. Vesuvianite=American jade, brown jacinth, California jade, californite, cyprine, greenstone, idocrase, Italian chrysolite, jade, Oregon jade, Vesuvian gem, volcanic chrysolite, volcanic scoria, white jade, xanthite.

W.

Wardite.

Willemite=troostite.

Wollastonite.

Z.

Zincite.

Zircon=Ceylonese zircon, hyacinth, jacinth, jargon, jargoon, matara diamond. Zoisite=rosaline, thulite.

#### APPENDIX 5.

### INDUSTRIAL USES OF PRECIOUS STONES.1

In the following paragraphs are mentioned some industrial uses of minerals of gem quality. In addition to ornamentation, all gem minerals are of value as specimens for collections, for use in standardization (for example, fluorite and quartz as standards of densities and of refractive indices), and as sources of material for investigation, both industrial and scientific. These uses are therefore not always repeated under the different mineral names. Ornamentation itself covers a variety of utilization, such as for jewelry, knife handles, paper weights, and pipes (meerschaum).

Agate.—Mechanical bearings and supports, scale bearings, balls for water meters, mortars for laboratory use, spatulas, paper knives, playing marbles, and small ornaments.

Azurite.—Ore of copper; pigment for paint.

Azurmalachite.—Ore of copper.

Calcite.—See Iceland spar.

Chromite.—Ore of chromium.

Chrysocolla.—Ore of copper.

Cobaltite. - Ore of cobalt.

Corundum.-See Sapphire.

Diamond.—Cutting, grinding, engraving, boring, and polishing material; supports for bearings and pivots; dies for wire drawing; tips for phonograph needles.

Epidote.—For coloring artificial slate and roofing material.

Fluorite. - See Optical fluorite.

Franklinite.—Ore of manganese and zinc.

Garnet.—Abrasive; for watch jewels or jeweled bearings; as tared weights.

Garnierite.—Ore of nickel.

Gypsum.—Used in manufacture of artificial pearls—the so-called "Roman pearls."

Hematite.—Ore of iron.

Iceland spar.—Iceland spar is a variety of calcite, clear and transparent and unusually free from imperfections and impurities. Transparent crystals or cleavage pieces of calcite of any appreciable size are very rare, and as Iceland has furnished almost all of such material used the name Iceland spar has been given it.

Elongated cleavage rhombohedrous of Iceland spar are used in the manufacture of nicol prisms, which are an essential part of optical instruments requiring plane polarized light, as, for example, certain microscopes, dichroscopes, and saccharimeters. The material, on account of its simple chemical composition and purity, finds application in chemical standardization. Iceland spar is also used in the manufacture of some kinds of glass, and some of it is sold as mineral specimens.

Pieces of Iceland spar, either in single untwinned crystals or parts of such crystals or in homogeneous untwinned cleavage rhombohedra, which are large enough to yield a rectangular prism at least 1 inch long and half an inch thick each way and which possess the properties described below, are suitable for optical purposes. The colorless material must be so clear and transparent that it is limpid and pellucid.

¹ Dr. W. T. Schaller, Mineral Resources of the United States, 1918.

It must not be partly opaque on account of numerous cracks or fractures, must not show any internal, iridescent, or rainbow colors due to incipient cracks along fracture lines, nor any cleavage, nor twinning planes. Neither can there be any capillary or larger tubelike cavities, nor cavities or bubbles of any shape, nor inclusions, as isolated particles, veins, or clouds, composed of minute crystals of some other mineral or of any kind of foreign substance. The spar should not be discolored or stained by the presence of any clay, iron oxide, or other material. It should be noted that many of the inclusions and imperfections of Iceland spar are not always scattered irregularly through the mineral or even segregated in distinct masses, but frequently lie in a distinct but very thin plane which can hardly be seen if looked at on edge. In examining a piece of Iceland spar for defects the piece should therefore be turned in all directions while held to the light.

The material suitable for optical uses naturally brings the highest prices, as it has to be at least of the dimensions already given. Specimen material is generally of a larger size. The material used for standardization, chiefly chemical, need be of no special size, and the smaller pieces are as usable as the larger ones.

Although calcite is, next to quartz, the commonest mineral, the only locality outside of Iceland known to produce the variety Iceland spar in commercial quantity is in Montana, about 9 miles from Gray Cliff, Sweet Grass County, on the main line of the Northern Pacific Railway. The spar occurs in a nearly vertical fissure vein from 3 to 8 feet thick, which strikes northwest, traversing a gneissic rock for several miles.

Jasper.—See Agate.

Malachite.—Ore of copper, pigment for paint.

Mariposite.—Pigment for paint.

Meerschaum.—Pipe bowls; cigar and cigarette holders.

Optical fluorite.—Fluorite, commonly called fluorspar, is a common mineral but is very seldom found in pieces clear enough and large enough to be of special use in the manufacture of certain optical lenses and prisms. Fluorite of the requisite qualities, as described below, suitable for such use is known as "optical fluorite." Any deposit of fluorite may yield a small quantity of such material, but at present about the only localities known to produce it are southern Illinois; Meiringen, Switzerland; and Obira, Bungo, Japan. Optical fluorite is cut into lenses and placed between glass lenses. It forms the apochromatic objective for microscopes and similar optical instruments, the fluorite lens correcting the spherical and chromatic errors of the glass lens systems. This result is due to the low refractive power, weak color dispersion, and single refraction of fluorite. These apochromatic lenses represent the finest type of microscope objectives made. The use of such a fluorite lens greatly increases the value of a microscope and if optical fluorite were more abundant many more microscope objectives would be equipped with such lenses.

Optical fluorite is also used in the lenses of certain telescopes, in making prisms for spectrographs in ultra-violet work, and in other optical apparatus where transparency in the ultra-violet and infra-red parts of the spectrum is necessary.

¹ The optical variety of Iceland spar produced in the United States, sold, a pound, for \$3 to \$4 in 1914, about \$8 in 1915, and as high as \$20 in July, 1918. The specimen variety sells for considerably less, and material for standardization sells for from \$1 to \$2 a pound.

The following firms are buyers of Iceland spar suitable for optical use: Bausch & Lomb Optical Co., Purchasing Department, Rochester, New York: Central Scientific Co., 460 Ohio Street east, Chicago, Illinois; Gilbert S. Day, Superintendent Optical Department, Eastman Kodak Co., Rochester, New York:

The market for specimen spar is irregular, as the demand is usually very light. The best market will probably be found with some of the larger mineral dealers.

Standardization material may be sold to large dealers in general chemicals as well as to mineral dealers.

Optical fluorite must yield or contain pieces at least one-fourth of an inch in diameter, which must be clear and colorless and free from all defects. Defects consist of internal cracks or cleavage planes, bubbles, or inclusions of dirt or mineral matter. The presence of faintly developed or incipient cleavage planes or fracture surfaces usually may be determined, if not readily visible, by moistening the specimen with kerosene. The material must not show any anomalous double refraction. Absolutely clear-water material is of the highest value, but very faint tints of green, yellow, or purple do not render the material useless.

Suitable material has been obtained from several of the fluorite mines in Hardin County, Illinois, and may also occur in the extension of this fluorite belt in western Kentucky. Although fluorite is found in many other States, practically none of them is known to contain any "optical fluorite."

Quartz.—See Rock crystal.

Rock crystal.—The perfectly clear and colorless variety of quartz is called rock crystal.

It furnishes the material for certain special glasses and fused silica ware; and it is used in wedges for microscopic work, as spectographic prisms for special researches and as mechanical bearings. A use in connection with certain sounding boxes has recently been developed.

Sepiolite.—See Meerschaum.

Sapphire.—The variety of gem corundum used for other purposes than jewelry is called sapphire, irrespective of its color. It is used for mechanical bearings and pivot supports, especially in watches and phonograph needles (mostly artificial sapphire).

Topaz.—Abrasive.

Tourmaline.—In the tourmaline tongs or in polarizing forceps, a very simple form of polariscope.

Fluorite suitable for optical use is valued at from \$1 to \$10 a pound, according to the size of the piece suitable for cutting as well as to its quality. The present yearly requirement is not large—perhaps several hundred pounds—but under proper conditions and with a dependable steady supply this requirement may be increased.

Possible buyers of optical fluorite are: Bausch & Lomb Optical Co., Rochester, New York; Spencer Lens Co., Buffalo, New York; Ward's Natural Science Establishment, Rochester, New York; United States Bureau of Standards, Washington, District of Columbia.



#### APPENDIX 6.

#### TABLES FOR THE IDENTIFICATION OF PRECIOUS STONES.

The accurate identification of a precious stone, even by an expert, is often a matter of considerable difficulty, and, indeed, sometimes rendered quite impossible by the manner in which the stone is mounted. The task, as a rule, is quite beyond the skill of the untrained. The method given below has been prepared by Dr. Edgar T. Wherry, formerly in charge of the Division of Mineralogy. The appliances needed comprise:

Sharp-pointed fragments of the minerals diamond, corundum, and quartz, preferably set in wooden handles the size of ordinary lead pencils.

Cleavage pieces or crystals, with good bright surfaces, of the minerals corundum, quartz, and feldspar (microcline).

Some means for determining specific gravity, such as picnometer, fine platinum-wire cage to be hung on chemical balance, small Nicholson hydrometer, etc. Liquids with high specific gravities, upon which stones of lower gravity will float, such as methylene iodide, specific gravity 3.30; acetylene tetrabromide, specific gravity 2.95; and bromoform, specific gravity 2.85, are also useful.

A microscope provided with nicol prisms, and a small, round-bottomed glass dish to be placed in the center of its stage, in which the stone can be immersed in a high-refracting liquid such as  $\alpha$ -mono-brom-naphthalene, n=1.66.

The stone is:

- I. Colorless, white, or very pale tinted.
- A. Transparent or nearly so.
  - (a) Hardness 9 or greater; not scratched by corundum point.
    - 1. Scratches corundum surface; not scratched by diamond point....Diamond.
    - 2. Does not scratch corundum surface......Corundum (white sapphire).
  - (b) Hardness 8 to 7; scratched by corundum, but not by quartz.
    - 1. Specific gravity very high, 4.5......Zircon.
    - 2. Specific gravity high, 3.5......Topaz.
  - (c) Hardness less than 7; scratched by quartz.
    - 1. Isotropic between crossed nicols under the microscope.....Glass (artificial).
  - B. Opaque or nearly so.
    - (a) Hardness greater than 6; scratch microcline.
    - (b) Hardness less than 6; do not scratch microcline.

(White agalmatolite, serpentine, opal, and opaque glass belong here.)

4555°—22——16

II. Color violet, red-violet, and related hues.
A. Transparent or nearly so.
(a) Hardness 9 or greater; not scratched by corundum.
1. Does not scratch corundum surfaceCorundum (oriental amethyst).
(The rare violet-colored diamond belongs here; it scratches corundum.)
(b) Hardness 8 to 7; scratched by corundum, but not by quartz.
1. Specific gravity very high, 4Garnet (almandine and rhodolite).
2. Specific gravity high, 3.6Spinel.
3. Specific gravity rather high, 3.2Spodumene (kunzite).
4. Specific gravity medium, 2.65Quartz, amethyst.
(The rare violet-colored varieties of iolite, tourmaline, and zircon, and
the rare mineral axinite, belong here.)
(c) Hardness less than 7; scratched by quartz.
1. IsotropicGlass (artificial).
(The rarely used violet varieties of apatite belong here.)
B. Opaque or nearly so.
(a) Hardness greater than 6; scratch microcline.
(The rare violet chalcedony and the rare mineral dumortierite belong here.)
(b) Hardness less than 6; do not scratch microcline.
(The rarely used lepidolite, pyroxene variety violan, and opaque violet
glass belong here.)
III. Color blue and related hues.
A. Transparent or nearly so.
(a) Hardness 9 or greater; not scratched by corundum.
1. Does not scratch corundum surface
(The rare blue-colored diamond belongs here; it scratches corundum.)
(b) Hardness 7; scratched by corundum, but not by quartz.
1. Sp. gr. 4.6; color pale blue, essentialZircon.
2. Sp. gr. 3. 6; color deep green-blue, essential
3. Sp. gr. 3.5; color pale blue, disperse
4. Sp. gr. 3.1; color deep smoky or green-blue, essential. Tourmaline (indicolite).
5. Sp. gr. 2.7; color pale blue or green-blue, disperseBeryl, aquamarine.
6. Sp. gr. 2.6; pleochroic, blue to yellow
(The rare mineral euclase belongs here.)
(c) Hardness less than 7; scratched by quartz.
1. Isotropic
(The rare blue-colored varieties of apatite, fluorite, kyanite, and opal, and
the rare minerals benitoite and hauynite, belong here.)
B. Opaque or nearly so.
(a) Hardness greater than 6; scratch microcline.
1. Luster waxy (in part artificially colored by dyes)
2. Luster glassy; color due to inclusionsQuarts.
(b) Hardness 6 or less; do not scratch microcline.
1. Sp. gr. 3.8; color deep blue; effervesces with acid
2. Sp. gr. 2.8; color pale green-blue; luster waxyTurquois.
3. Sp. gr. 2.4; color mottled and showing pyrite dotsLapis-lazuli.
(Several little-used minerals belong here, such as calamine (copper-
stained), chrysocolla, crocidolite, smithsonite (copper-stained), sodalite, etc.;
also glass imitations of turquois.)
IV. Color green.
A. Transparent or nearly so.
(a) Hardness 9 or greater; not scratched by corundum.
1. Does not scratch corundum surfaceCorundum, oriental emerald.
(M) a way and a classification and belongs home it companies community

(The rare green-colored diamond belongs here; it scratches corundum.)

TV Color man Continued
IV. Color green—Continued.
A. Transparent or nearly so—Continued.
<ul> <li>(b) Hardness 8 to 7; scratched by corundum but not by quartz.</li> <li>1. Sp. gr. 3.7; color yellow-green, in artificial light red. Chrysoberyl, alexandrite.</li> </ul>
2. Sp. gr. 3.2; color pale brown-green or yellow-green
3. Sp. gr. 3.1; pleochroic, pale to deep green
4. Sp. gr. 2.7; color pale blue-green, faintly pleochroicBeryl.
5. Sp. gr. 2.7; color deep green, moderately pleochroicBeryl, emerald.
6. Sp. gr. 2.65; color pale, cloudy green, not pleochroicQuartz, prase.
(The rare green-colored varieties of euclase, topaz, and zircon belong here.)
(c) Hardness less than 7; scratched by quartz.
1. Sp. gr. 3.8; color deep yellow-green; isotropicGarnet, demantoid.
2. Sp. gr. 3.5; pleochroic, deep green-yellow to brown
3. Sp. gr. 3.4; pleochroic, yellow-green to green-yellowTitanite, sphene.
4. Sp. gr. 3.4; faintly pleochroic; color green-yellow Chrysolite, peridot.
5. Sp. gr. 3.3; not pleochroic; color pale greenPyroxene, diopside.
6. Sp. gr. 3.2; pleochroic, pale to deep greenSpodumene, hiddenite.
7. Sp. gr. 2.5; color dark brown-green; isotropicObsidian, moldavite.
8. Sp. gr. mostly below 3; isotropic
(The rarely used minerals dioptase and prehnite and the rare green-colored
varieties of apatite, enstatite, fluorite, and vesuvianite belong here.)
B. Opaque or nearly so.
(a) Hardness greater than 6; scratch microcline.
1. Sp. gr. 3.3; luster rather vitreous; color yellow-green.
Vesuvianite, californite.
2. Sp. gr. 3.3; luster rather greasy; color green or greenish grayJade (jadeite).
3. Sp. gr. 2.6; luster rather waxy; color pale blue-green.
Chalcedony, chrysoprase.
4. Sp. gr. 2.6; luster rather dull; color dark blue-greenChalcedony, plasma. (When plasma is spotted with red it is known as bloodstone.)
(h) Hardness 6 or less; do not seratab missoslina
(b) Hardness 6 or less; do not scratch microcline.
1. Sp. gr. 4; color intense green; luster rather silky
<ol> <li>Sp. gr. 4; color intense green; luster rather silky</li></ol>
<ol> <li>Sp. gr. 4; color intense green; luster rather silky</li></ol>
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1. Sp. gr. 4; color intense green; luster rather silky
1. Sp. gr. 4; color intense green; luster rather silky
1. Sp. gr. 4; color intense green; luster rather silky

tourmaline belong here.)

V. Color yellow—Continued.
A. Transparent or nearly so—Continued.
(c) Hardness less than 7; scratched by quartz.
1. Sp. gr. fairly high, 3.4; pleochroism distinctTitanite, sphene.
2. Sp. gr. mostly less than 3; isotropic
3. Sp. gr. very low, 1.1
(The rarely used yellow forms of apatite, chrysolite, fluorite, microlite,
sphalerite, spodumene, vesuvianite, and willemite belong here.)
B. Opaque or nearly so.
(a) Hardness greater than 6; scratch microcline.
1. Sp. gr. medium, 2.6 (in part artificially colored)
2. Like preceding, but more opaque
3. Luster silkyQuartz after crocidolite.
(b) Hardness less than 6; do not scratch microcline.
1. Sp. gr. mostly below 3; luster glassy
(The rare yellow varieties of serpentine and smithsonite, and the little
used mineral cancrinite belong here.)
VI. Color brown (including orange-color).
A. Transparent or nearly so.
(a) Hardness 9 or greater; not scratched by corundum.
(The rare brown-colored diamond belongs here.)
(b) Hardness 8 to 7; scratched by corundum but not by quartz.
1. Sp. gr. high, 4.5; double refraction strong, very brilliantZircon.
2. Sp. gr. high, 4.1; isotropic
3. Sp. gr. fairly high, 3
4. Sp. gr. medium, 2.7
(The rarely used mineral staurolite, and the rare brown-colored varieties
of andalusite, chrysoberyl, spinel, and topaz belong here.)
(c) Hardness less than 7; scratched by quartz.
1. Sp. gr. fairly high, 3.4; pleochroism distinct
2. Sp. gr. medium, mostly less than 3; isotropic
3. Sp. gr. very low, 1.1
(The rarely used minerals aximite, epidote, fluorite, chondrodite,
sphalerite, staurolite, and vesuvianite belong here.)
B. Opaque or nearly so.
(a) Hardness greater than 6; scratch microcline.
1. Sp. gr. high, 3.7; color deep brown
2. Sp. gr. medium, 2.6; in part artificially colored
3. Same, banded
4. Same, but more opaque
5. Same, but luster highly silkyQuartz after crocidolite.
(b) Hardness less than 6; do not scratch microcline.
· ·
1. Sp. gr. medium, 2.6       Obsidian.         2. Sp. gr. mostly less than 3       Glass (artificial).
(Some rarely-used varieties of feldspar and altered staurolite belong here.)
· · · · · · · · · · · · · · · · · · ·
VII. Color red or pink.  A. Transparent or nearly so.
(a) Hardness 9 or greater; not scratched by corundum.
1. Does not scratch corundum surface
(The rare pink colored-diamond belongs here; it scratches corundum.)
(THE 1916 bring colored-dismode neighbors, it sersection columnim.)

VII. Color red or pink—Continued.
A. Transparent or nearly so—Continued.
(b) Hardness 8 to 7; scratched by corundum but not by quartz.
1. Sp. gr. high, 3.9; color intense red; isotropicGarnet, pyrope, (etc.).
2. Sp. gr. fairly high, 3.6; color intense red; isotropicSpinel, balas-ruby.
3. Sp. gr. fairly high, 3.5; color orange-red to pink; anisotropicTopaz.
4. Sp. gr. fairly high, 3.1, color pink; pleochroism strong. Tourmaline, rubellite.
5. Sp. gr. medium, 2.7; color pink; pleochroism faintBeryl, "morganite."
(The rare pink grossularite garnet and the red variety of zircon belong
here.)
(c) Hardness less than 7; scratched by quartz.
(The little used mineral piedmontite, and the rare red-colored varieties
of amber, and pink-colored varieties of fluorite and spodumene-kunzite
belong here; also opal and artificial glass.)
<u> </u>
B. Opaque or nearly so.
(a) Hardness greater than 6; scratch microcline.
1. Sp. gr. fairly high, 3.3; color dull red or violet redZoisite, thulite.
2. Sp. gr. medium, 2.6; color pink, cloudyQuartz, rose.
3. Same, but color red
4. Same, but more opaque
5. Same, but banded
(b) Hardness less than 6; will not scratch microcline.
(The little used minerals lepidolite, rhodonite, and rutile belong here;
also coral and artificial glasses.)
VIII. Color black.
(a) Hardness 9 or greater; not scratched by corundum.
(Black diamond or carbonado belongs here; it scratches corundum.)
(b) Hardness 8 to 7; scratched by corundum but not by quartz.
1. Sp. gr. 2.7Quartz, smoky.
2. Same, more opaque; artificially colored
3. Same, banded
(The rarely used black varieties of spinel and tourmaline belong here.)
(c) Hardness less than 7; scratched by quartz.
1. Sp. gr. very high, 5.3; "streak" (powder) red
2. Sp. gr. medium, 2.5; glassyObsidian.
3. Sp. gr. medium; glassy
4. Sp. gr. lowJet (and coal).
(The little used minerals allanite, chromite, gadolinite, ilmenite, mag-
netite, rutile, and samarskite belong here.)
Possessing internal colors:
A. Transparent or nearly so.
(a) Hardness 9 or greater; not scratched by corundum.
1. Does not scratch corundum surface; int. refl. silvery, 6-rayed.
Corundum, asteria.
(b) Hardness 8 to 7; scratched by corundum but not by quartz.
1. Sp. gr. 2.7; int. refl. silky, forming fine sharp lineChrysoberyl, cat's-eye.
2. Sp. gr. 2.7; int. refl. silky, forming broad bandQuartz, cat's-eye.
(The rare tourmaline-cat's-eye belongs here.)
(c) Hardness less than 7; scratched by quartz.
1. Sp. gr. medium, 2.6; int. refl. blue to silvery-whiteFeldspar, moonstone.
2. Sp. gr. rather low, 2.2; int. refl. various brilliant colors
(Some amber, feldspar variety sunstone, obsidian, and various kinds of
artificial glass belong here.)

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Possessing internal colors—Continued.

- B. Opaque or nearly so.
  - (a) Hardness greater than 6; scratch microcline:
    - 1. (Some asteria corundum is practically opaque; see A. a 1.)

Corundum, asteria.

- 2. Int. refl. silky, forming broad band; color brown-yellow...Quartz, tiger-eye.
- 3. Int. refl. silky, forming broad band; color gray, green, etc..Quartz, cat's-eye.
- 4. Int. refl. spangled; color various.......Quartz, aventurine.
- (b) Hardness 6 or less; do not scratch microline.
  - 1. Sp. gr. 3.4; int. refl. bronzy; color dark brown.

Hypersthene (including bronzite).

- 2. Sp. gr. 2.7; shows pearly luster and delicate color-play......Calcite, pearl.
- 3. Sp. gr. 2.7; color gray; int. refl. blue, green, red, etc.. Feldspar, labradorite.
- 4. Sp. gr. 2.7; color gray; int. refl. red, spangled......Feldspar, sunstone.
- 5. Sp. gr. 2.5; color dull green; int. refl. silky, gray.......Serpentine, satelite.
- 6. Sp. gr. 2.3; very soft, color white; int. refl. strongly silky.

Gypsum, satin-spar.

# APPENDIX 7.

#### STATISTICS OF PRODUCTION.1

## Value of precious stones produced in the United States, 1913-1919.

	1913	1914	1915	1916	1917	1918	1919
Beryl	\$1,615	\$2,395	\$1,675	\$2,031	\$2,178	\$1,906	(a)
Copper-ore gems	2,350	1,280	1,120	1,713	2,857	2, 299	(a)
Corundum	238, 835	61,032	88, 214	99, 180	54, 204	42,414	\$40,304
Diamond		765	608	2,680	4, 175	1,910	(6)
Feldspar		449	368	305	(8)	(6)	(a) (b)
Garnet		1,760	4, 523	1.542	` 624	1,277	1,630
Hematite	1,200	2,.00	126	(8)	(b)	138	(8)
Jade		300		(-)			(-)
Opal		1,114	1,850	1,838	805	6,304	(a)
Peridot	375	7100	(8)	455		1.018	(-)
Pyrite	50	100	1,042	2,075	(8)	(8)	
Quartz		18,838	35, 724	25,707	28, 273	15, 211	17 822
Rhodonite	165	1,050	85	(8)	(6)	515	17,632 160
Smithsonite	50	50		(4)	\ \X	313	100
Spodumene		4,000	(b) (b) (b)	(b) _	(b) (b) (b)	281	
		2,000	\ <b>``</b> ``\	47	\ <b>%</b> {	(b) 201	(b)
Thomsonite		1,380	862	1,005	230	907	210
Topaz		7,980	10,969	50,807	12, 452	6,206	17,700
Tourmaline	7,630	12,980		21,811	14, 171		99 750
Turquoise	8,075	13,370	11,691	21,011	13,111	20,667 753	22, 750 925
Variscite	6, 105	5,055	3,867	3,140	2,350	320	923
Vesuvianite	152	1,425	1,535	(¢)	2,765	320	
Beryl, copper-ore gems, dia- mond, opal	(3)		(4)	(4)	(-)	(4)	0 000
mond, opal	(e)	(e)	(c)	(e) 	(c)	(c)	8,832
Miscellaneous gems	2,920	2,287	d 6,172	e 3, 457	1 5,928	g 4,397	A 1,620
	319, 454	124, 651	170,431	217, 793	131,012	106, 523	111,763

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c Less than 3 producers; figures combined with others to avoid disclosing confidential information.

b Small production included under "Miscellaneous gems."

c For value of production in this year, see above.

d Includes aparite, calamine, chlorastrolite, crocidolite, datolite, fossil coral, Iceland spar, kyanite, lapis fazuli, obsidian, peridot, phenacite, rutile, smithsonite, spodumene (kunzite), staurolite, thomsonite, titanite, and gircon.

Includes obligations of the control o

titanite, and zircon.

« Includes chlorastrolite, datolite, epidote, fossil coral, hematite, kyanite, lazulite, rhodonite, rutile, sepiolite, serpentine, spodumene, staurolite, and vesuvianite.

/ Includes andalusite, chlorastrolite, datolite, epidote, feldspar, fossil coral, hematite, Iceland spar, lapis lazuli, obsidian, peridot, phenacite, pyrite, rhodonite, rutile, sepiolite, smithsonite, spodumene, staurolite, thomsonite, willemite, and zoisite.

/ Includes andalusite, calamine, chlorastrolite, datolite, epidote, feldspar, fluorite, Iceland spar, lapis lazuli, mariposite, meerschaum, obsidian, phenacite, pyrite, satin spar (gypsum), staurolite, thomsonite, willemite, and zoisite.

/ Includes chlorastrolite, datolite, feldspar, fossil coral, hematite, jet, lapis lazuli, meerschaum, spinel, spodumene (kunzite), thomsonite, and Iceland spar.

¹ From Mineral Resources of the United States, 1919. Pt. 2, 1921.

#### APPENDIX 8.

#### SELECTED BIBLIOGRAPHY.

The very full bibliographies given in Tagore's "Mani-Málá," Feuchtwänger's "Treatise on Gems," Wodiska's "Book of Precious Stones," and Pogue's "The Turquoise" seemingly render unnecessary a reference here to any but a few of the more general treatises.

BAUER, MAX. Edelsteinkunde.

Leipzig, 1896.

English translation by L. J. Spencer. Lippincott & Co., Philadelphia.

BOUTAN, M. E. Le diamant.

Paris, 1886.

Contains a very full bibliography up to date of issue.

BURNHAM, S. M. Precious stones in nature, art, and literature. Boston, 1886.

CATTELLE, W. R. Precious stones. A book of reference for jewelers. Philadelphia and London, 1903.

Church, A. H. Precious stones, considered in their scientific and artistic relations.

London, 1882.

CLAREMONT, L. Precious stones.

Philadelphia and London. J. B. Lippin cott Co., 1903, 224 pp., xxx plates, 8°.

DIEULAFAIT, L. Diamonds and precious stones; a popular account of gems. New York, 1874.

DOELTER, C. Edelsteinkunde. Bestimmung und Untersuchung der Edelsteine und Schmucksteine; Kuenstliche Darstellung der Edelsteine.
Leipzig, 1893.

EMANUEL, H. Diamonds and precious stones.

London, 1865.

Contains a very full bibliography to date of publication.

ESCARD, J. Les pierres precieuses (precious stones), 520 pp., illustrated with colored plates.

Paris, H. Dunod et E. Pinat, 1914. (About \$7.)

FARRINGTON, O. C. Gems and minerals. 229 pp., illustrated with colored plates. Chicago, A. W. Mumford Co., 1903. (\$3.)

FEUCHTWANGER, L. A popular treatise on gems in reference to their scientific value. New York, 1872.

FURTWÄNGLER, A. Die antiken Gemmen. Geschichte der Steinschneidekunst im klassischen Altertum.

Leipzig, Berlin: Gieeck and Devrient, 1900. 3 vols, illustrations, plates.

GOODCHILD, W. Precious stones. 309 pp., illustrated. Archibald Constable and Co. Ltd. (\$2.)

London, 1908.

HAMLIN, A. C. The tourmaline.

Boston, 1873.

HINDMARSH, R. Precious stones,, being an account of the stones mentioned in the Sacred Scriptures.

London, 1851.

JANETTAZ, N. and E. FONTENAY, Em. VANDERHEGEN, and A. COUTANCE. Diamant et pierres precieuses.

Paris, 1880.

Digitized by Google

JAZEK, BOH. Aus dem Reiche der Edelsteine (In the domain of the precious stones), 171 pp., 8 pls., figs.

Prague, Austria, E. Weinfurter.

King, C. W. The natural history of gems or decorative stones. London, 1867.

- Kunz, George F. Gems, jewelers' materials, and ornamental stones of California, 2d ed.: California Min. Bureau, Bull. 37, 171 pp., illustrated (4 colored plates), 1905. (Price and postage, 58 cents.)
- The curious lore of precious stones, 406 pp., 61 pls. (6 in color), figs. Philadelphia, J. B. Lippincott Co., 1913. (\$5.)
- Gems and precious stones of North America, 367 pp., illustrated with colored plates.
  - New York, Scientific Publishing Co., 1890. (\$10.)
- --- (CHARLES H. STEVENSON). The Book of the Pearl.

New York City, 1908, The Century Co.

- The fresh-water pearls and pearl fisheries of the United States. (In Bulletin of the United States Fish Commission, 1897, p. 375.)
- LIESEGANG, R. E. Die Achate (Agates), 118 pp., illustrated. Dreeden and Leipzig, 1915.
- Lown, Clarence, and Booth, Henry. Fossil Resins, a compilation. New York, 1891, N. D. C. Hodges.
- MAWE, JOHN. A treatise on diamonds and precious stones, including their history, natural and commercial. To which is added some account of the best method of cutting and polishing them.

  London, 1813.
- POGUE, J. E. The Turquoise: A study of its history, mineralogy, geology, ethnology, archeology, mythology, folklore, and technology. Nat. Acad. Sci., Mem., vol. 12, pt. 2, No. 3, 206 pp., 22 pls. (1 colored), figs., 1915.

Contains full bibliography to date.

- ROSENMULLER, E. F. C. Mineralogy of the Bible. Translated by Repp and Morren. Edinburgh, 1840.
- ROTHSCHILD, M. D. Handbook of precious stones. New York, 1890.
- SMITH, G. F. H. Gem stones and their distinctive characters. 312 pp., illustrated with colored plates.

London, 1912, Methuen and Co. Ltd. (\$2.10.)

- Schaller, W. T. The production of precious stones. Mineral Resources of the United States, 1915-1919.
- STERRETT, D. B. The production of precious stones.
  - Washington, D. C., 1907. Mineral Resources of the United States, 1906-1914.
- STREETER, E. W. Precious stones and gems.

London, 1877.

—— Great diamonds of the world.

London, 1892.

TAGORE, S. M. Mani-Málá, a treatise on gems. 2 vols. Calcutta, 1879.

Contains a bibliography of Sanskrit, Persian, Arabic, and other oriental works on gems.

WILLIAMS, G. F. The diamond mines of South Africa. 2 vols., 359 and 353 pp., illustrated.

New York, B. F. Buck and Co., 1905.

Wodiska, Julius. A book of precious stones. 363 pp., illustrated with colored plates. New York, 1910, G. P. Putnam's Sons.

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THE EAST HALL. CONTAINS MECHANICAL AND ELECTRICAL ENGINEERING COLLECTIONS.

# SMITHSONIAN INSTITUTION UNITED STATES NATIONAL MUSEUM Bulletin 119

# CATALOGUE OF THE MECHANICAL ENGINEERING COLLECTION IN THE UNITED STATES NATIONAL MUSEUM

# MOTORS, LOCOMOTIVES, AND SELF-PROPELLED VEHICLES

EDITED AND COMPILED BY

CARL W. MITMAN

Curator, Divisions of Mineral and Mechanical Technology



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### ADVERTISEMENT.

The scientific publications of the United States National Museum consist of two series, the *Proceedings* and the *Bulletins*.

The *Proceedings*, the first volume of which was issued in 1878, are intended primarily as a medium for the publication of original, and usually brief, papers based on the collections of the National Museum, presenting newly acquired facts in zoology, geology, and anthropology, including descriptions of new forms of animals, and revisions of limited groups. One or two volumes are issued annually and distributed to libraries and scientific organizations. A limited number of copies of each paper in pamphlet form is distributed to specialists and others interested in the different subjects as soon as printed. The date of publication is printed on each paper, and these dates are also recorded in the tables of contents of the volumes.

The Bulletins, the first of which was issued in 1875, consist of a series of separate publications comprising chiefly monographs of large zoological groups and other general systematic treatises (occasionally in several volumes), faunal works, reports of expeditions, and catalogues of type specimens, special collections, etc. The majority of the volumes are octavos, but a quarto size has been adopted in a few instances in which large plates were regarded as indispensable.

Since 1902 a series of octavo volumes containing papers relating to the botanical collections of the Museum, and known as the *Contribu*tions from the National Herbarium, has been published as bulletins.

The present work forms No. 119 of the Bulletin series.

WILLIAM DEC. RAVENEL,

Administrative Assistant to the Secretary,
in charge of the United States National Museum.

WASHINGTON, D. C., December 23, 1921.

2

#### PREFACE.

In the year 1884 a Section of Transportation was organized in the United States National Museum for the purpose of preparing and assembling educational exhibits of a few objects of railroad machinery which had been obtained both from the Centennial Exhibition held in Philadelphia in 1876 and still earlier as incidentals to ethnological collections, and to secure other collections relating to the railway industry.

From this beginning the section was theoretically enlarged to include the whole field of engineering, but it has actually enlarged in the fields of mechanical engineering, especially the early developments of the steam engine, locomotive, and internal combustion engine; electrical engineering, particularly the development of the telegraph, telephone, and the electric light; metrology, particularly horology; and naval architecture.

The primary object of these collections is to visualize broadly the steps by which advances have been made in each field up to the present day; to show the layman the fundamental and general principles which are the basis for the developments, and to familiarize the engineer with other branches of engineering than his own.

While this purpose has been continually in mind to those in charge, an examination of the collections will show that none of them has reached the goal. Some lack the starting points; others have certain portions of their development completed; and but few may be said to be up to date. Many reasons might be given for this condition of affairs, the chief ones being:

- 1. The Museum is dependent almost wholly upon gifts or loans for augmenting its collections, and while those in charge know what objects are desirable, the general public does not.
- 2. Funds for the employment of preparators, model makers, etc., are limited, so that the completion of the collections in this way is a slow process.
- 3. Limited exhibition space, which has prevented in some instances the acquisition of objects of particular value to the collections.

The general limitations of the collections as noted are applicable to the mechanical engineering collection, and this catalogue is prepared in the belief that an acquaintanceship with the collection as it now stands will lead to the cooperation necessary to make it complete.

C. W. M.

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# CATALOGUE OF THE MECHANICAL ENGINEERING COLLECTION IN THE UNITED STATES NATIONAL MUSEUM

### MOTORS, LOCOMOTIVES, AND SELF-PROPELLED VEHICLES

EDITED AND COMPILED BY

CARL W. MITMAN

Curator, Divisions of Mineral and Mechanical Technology

# PART I. AGENTS OF POWER.

#### MECHANICAL ELEMENTS.

The desire or the necessity of moving some heavy object, probably a bowlder, led primitive man to the discovery of the lever and its power to do work. His first application undoubtedly was that of placing the end of a stick of wood or his ever-present club under the object and pulling upward on the other end. Thus was born the first mechanical element which has survived to the present day, and may be seen in a variety of forms, both simple and complex, such as the nail puller, can opener, scissors, cogwheel, typewriter action, etc.

Next in order of discovery, probably, was the inclined plane, a very old mechanical element, which is even to-day applied in mechanisms of wide variety. An explanation advanced as to how the placing of heavy stones in the building of the pyramids and temples of ancient Egypt was accomplished is to the effect that inclined roadways were built to the height desired and that the massive stones were then drawn up and set in place. Two inclined planes, placed back to back, form a wedge whose many uses need not be enumerated. Then followed at intervals of time the roller, the pulley and block, and the windlass, all coming into being as direct aids of muscular effort.

Model of Roller, Lever, and Inclined Plane. (Scale 1:6.) Made in the Museum.

The combination of these three powers made it possible for the engineers of antiquity in eastern and western nations to transport and lift in place the heavy objects of which monuments and temples were constructed. This ancient method is universally adopted for transporting heavy loads.

Cat. No. 181,251 U.S.N.M.

### Model of Method of Rolling a Marble Column. (Scale 1:6.) Made in the Museum.

This method of rolling a load was in vogue in Greece about 560 B. C. It is described by Vitruvius (Book X, chap. 6) and was adopted by Ctesiphon for transporting the columns from the quarry to the temple of Diana at Ephesus, during the sixth century B. C. Cat. No. 181,257 U.S.N.M.

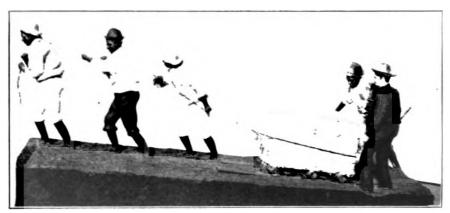


FIG. 1.—THE COMBINED APPLICATION OF THE ROLLER, LEVER, AND INCLINED PLANE.

### Model of Method of Rolling a Marble Prism. (Scale 1:6.) Made in the Museum.

Vitruvius writes (Book X, chap. 6) that the stone "was 12 feet long, 8 feet wide, and 6 feet high," and that "Paeonius made two wheels about 15 feet diameter, and fitted the ends of the stone into

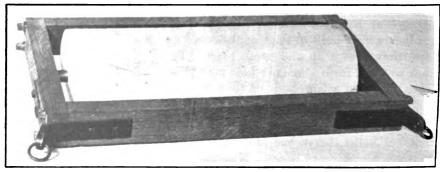


FIG. 2.-THE BOLLING LOAD.

these wheels. To connect the two wheels he framed into them, round their circumference, small pieces of 2 inches square, not more than 1 foot apart, each extending from one wheel to the other, and thus inclosing the stone. Round these bars a rope was coiled, to which

the traces of the oxen were made fast, and, as it was drawn out, the stone rolled on by means of the wheels." The method of the rolling load was adopted by Paeonius in the first century B. C. for transporting the new base of the colossal statue of Apollo from the quarry to the temple erected to that god.

Cat. No. 181,258 U.S.N.M.

#### NATURAL FORCES.

The time came in the course of civilization's advancement when power requirements exceeded those which could be developed by muscular energy, and accordingly man proceeded to utilize the natural forces about him. These included the domesticated animal, the wind and the water, whose potential energy was converted into work through the medium of the horse gin and treadmill, the wind-mill and the water wheel, respectively. Whereas man in turning a crank by hand could do work at the rate of about one-tenth horse-power a minute in an eight-hour day, the ox in the circular-track gin could develop five-tenths and the horse eight-tenths horsepower; the crude windmill about 4 horsepower; and the crude water wheel about the same amount.

#### WINDMILLS.

Wind for propelling ships was developed at a very early date, but the time of its use for industrial purposes is much later, the exact time being in dispute. Windmills were common beginning about the twelfth century A. D. It is said that the first type adopted to present the vanes or sails toward the wind was to float the mill on water and turn it as required. The next step was to put the mill on a post and turn the building on this as an axis. Following this the cap or roof only was revolved—a Dutch invention of the sixteenth century. The progressive improvements which followed consisted mainly in governing, regulating the sail area in accordance with the wind's force, first by reefing and later by altering the angles at which the sails were presented to the wind.

The windmill, of course, found its greatest application in flat country, and in Holland was probably more universally adopted than in any other country, there being at one time 12,000 mills in operation, averaging 8 horsepower each.

The modern windmill, used mainly for raising water, is much smaller through the use of steel and lighter metals. Disks, 6 to 30 feet in diameter, made up of a number of vanes, take the place of the cloth sail. In one type in particular there are two series of concentric blades fastened to the purlines of a braced radial frame. The blades are fixed at an angle of about 35° to the plane of the wheel and a peculiarly constructed mechanism turns the wheel

edgewise to the wind to stop it, or to regulate the position to conform to the wind pressure.

#### WATER WHEELS.

It is quite probable that the current wheels used from time immemorial, particularly in the Orient, for raising water, and locally known as the Persian wheel, the Noria and the Tympanum, were the forerunners of the water wheel used for the development of power. At all events, water wheels were used to turn mill stones in 50 B. C., according to Strabo, and from this time on were gradually improved, particularly as to their efficiencies. This was brought about mainly through the mode of directing the water to the wheel so that there were developed many types, such as the overshot, undershot, breast, flutter, Barker, and several others whose efficiencies ranged from as much as 75 per cent to as little as 25 per cent.

The modern development of the water wheel is the turbine, a water wheel revolving on a vertical axis and having peculiarly shaped buckets or vanes. Its greater efficiency and ability to take advantage of high as well as low falls of water has practically caused the elimination of the earlier water wheel. Since its invention by Fourneyron in 1823, many types have been developed which, however, may be classified into high and low pressure turbines, and further subdivided according to the direction of flow of the water through the machine. Fourneyron directed the water to the center of the wheel and discharged it outward (radially). The Chase is just the reverse, the water entering at all points around the circumference and escaping at the center and downward. Another type, of which the Jonval is an example, invented in 1841, receives the water above and directs it downward through a set of guides to the wheel, the water discharging below.

## Model of Leffel Double Turbine Water Wheel. Made and Presented by James Leffel & Co.

This belongs to the class of water wheels in which the water enters the buckets tangentially at the surface and is discharged at the center. This particular turbine has two sets of buckets, one with a central and the other with a vertical discharge, each receiving its water from the same set of guides at the same time and the water leaving each wheel independently. The two sets are cast together and attached to the same shaft.

Cat. No. 180,193 U.S.N.M.

#### STEAM ENGINES.

Connected with the history of the steam engine are the names Hero, Anthemius, da Vinci, Porta, Branca, de Caus, Marquis of Worcester, Papin, Savery, Newcomen, and Watt, names of men whose efforts to utilize steam to do work, date, it is now believed, from 50 A. D. to 1760 A. D. If the steam engine is considered in its modern sense, however, then Hero's "aeolipile," and the engines made by Papin about 1690 A. D., are the only true ones, for those which followed Hero's and preceded Papin's engines were contrivances for raising water by steam and had no means of operating machinery directly, although they raised water which in turn operated a water wheel.

Hero's engine is a true rotary steam engine working on the same principle as that of the turbine. Branca (A. D. 1629) directed

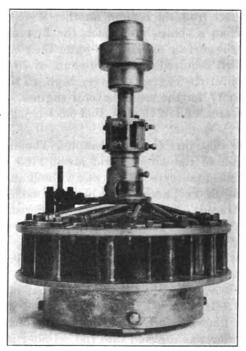


FIG. 8 .- THE LEFFEL TURBINE.

steam to strike the vanes of a wheel, causing it to rotate. Dr. Denis Papin, of Blois, France, built a water elevator consisting of two vessels, one in which steam was generated and the other containing the water to be elevated. The former was equipped with a safety valve and the latter contained a float resting on the water and upon which the steam acted, thus decreasing the amount of condensation. This float was the precursor of the piston, invented by Papin. Thomas Savery patented in England a "fire engine" in 1698, which raised water by the direct pressure of steam alternating with atmospheric pressure, which proved to be the first practical application of steam power.

There existed at that time a great sphere for the employment of such an engine in the drainage of the mines of Cornwall and Devonshire, for, although the miners' made use of both animal and water power to clear the workings from the steadily increasing flow of water, the deepening of the mines increased the difficulties of removing the water by these means, and the limit of their use had about been reached. Savery's engines were erected at several mines, but only at those whose depth did not exceed the maximum lifting capacity of the engine-about 80 feet. For deeper mines Savery proposed the erection of as many engines as the increased depth of the mine required; that is, a mine 250 feet deep would have three engines, one 80 feet from the bottom, another 80 feet above the first, raising water from a sump into which the first exhausted. and a third engine on the surface to raise the water the remaining distance. This maximum lift required a steam pressure of 30 pounds, and the fuel consumption of the engine was very high, so that the combination of the necessity for the use of several engines, of the danger of high boiler pressures, and of the low fuel efficiency greatly restricted the use of Savery's engine.

It is probable that this failure prompted Thomas Newcomen to turn his attention to the subject, and about 1705 he perfected an engine of the atmospheric type, which was without any of the features objected to in the Savery, and from which the modern steam engine can be directly traced. Newcomen's engine differed primarily from Savery's in that it raised water by atmospheric pressure alone, the steam being only used to create a vacuum.

Although Newcomen included all of the valuable features of the engines of his predecessors in those he built, the finished engine was so superior to any that had gone before that it was practically a new invention. It included the separate vessel in which to generate the steam; likewise, through an accident which punctured the cylinder, cold water was injected into the cylinder in order to effect a speedy vacuum under the piston; and a valve gear was provided whereby the machine could be made to repeat its movements automatically. Since Savery's patent was sufficiently general to cover Newcomen's engine, although the principal was different, the two joined hands in the construction of engines, and for upward of 60 years after the introduction of the first engine Newcomen engines proved to be the only economical agent for draining mines.

During the years 1763-1764 James Watt, while engaged in repairing a model of a Newcomen engine, was impressed by the enormous consumption of steam and made some experiments and measurements of the temperature, pressure, and volume of the steam generated in the model, and also of the quantity of water required to condense the steam. These experiments showed that the chief

waste in the engine arose from cooling of the cylinder and piston surfaces by the water spray used to condense the steam. To reduce this waste, Watt invented the separate condenser, which when installed on a Newcomen engine cut the fuel consumption in half. He likewise covered the top of the cylinder to exclude the cold air and exposed it to the steam. These improvements, together with the air pump, were embodied in the patent secured by Watt in 1769 and extended in 1775 for a period of 25 years, just at the time when he entered into partnership with Matthew Boulton for the manufacture of single-acting beam pumping engines.

The changes Watt made in the construction of the engine rendered it almost a new machine. The most important of these improvements were:

- (1) Surrounding the steam cylinder with a jacket, inclosing the whole in a casing, and doing away with the necessity of introducing into the cylinder water or other substances colder than the steam itself.
  - (2) Condensing the steam in a separate vessel.
  - (3) Removal of the uncondensed air or vapor by an air pump.
- (4) Substitution of the expansive force of steam instead of the pressure of the atmosphere acting on the piston, whereby the engine ceased to be an atmospheric and became a steam engine.
- (5) Use of grease to render the piston steam-tight instead of water, as formerly employed.
- (6) Adaptation of the principle of expansion by cutting off the steam before the piston had finished its stroke.
  - (7) Introduction of the double-acting engine.
- (8) The mechanism known by the name of "parallel motion." This was first designed for the double-acting engine to replace the toothed rack and sector required for giving an upward as well as a downward propulsion. It was afterwards applied to single-acting engines, being a much more suitable method of connecting the piston rod to the beam than the original arc and chain.

All of these inventions were protected by patents, but, independently of those thus secured, Watt made other alterations of very considerable value. Thus he changed the dome boiler formerly used with the atmospheric engine to the wagon-shaped one, which has since been applied generally to low-pressure engines. By this change more heating surface was gained for a given cubic content, the boiler was more easily made, and was of a more convenient form for setting. He also placed the boiler upon a separate foundation, removing it from beneath the cylinder. This was a great improvement, for in the atmospheric engine, the cylinder of which stood on the top of the dome boiler, the vibration caused by the motion of the engine soon rendered the boiler leaky and deranged the position of the cylinder.

The great demand which resulted for steam engines, after the introduction of Watt's engines, stimulated other inventors, the most prominent of whom probably was Jonathan Hornblower, who in 1781 patented and constructed the compound single-acting engine with a high-pressure cylinder placed between the low-pressure cylinder and the beam center. On account of the low boiler pressure in use at that time, this engine proved less economical than the Watt engine, and since it made use of the separate condenser was an infringement of Watt's patent of 1769.

Upon the expiration of the Watt patent, that is, about 1800, an advance began in the development of the steam engine which is still continuing. The vacuum became of relatively less importance; in fact, with the high-pressure engine it was sometimes dispensed with entirely. One of the first to advocate and introduce the high-pressure engine was Richard Trevithick, who patented in 1802 a semi-portable engine of this type. The application of this engine to the locomotive was probably the most important step.

# Model of Hero's Rotary Steam Engine. Deposited by the United States Department of the Interior.

The philosopher, Hero, of Alexandria, Egypt, prepared a treatise entitled "Spiritalia seu Pneumatica." In it are described a number of interesting forms of water and heat engines, and among the latter an apparatus moved by the force of steam somewhat as represented in the model. This earliest of steam engines, which Hero called "aeolipile," consisted of a globe suspended between trunnions through one of which steam enters through pipes from a boiler below. The hollow-bent arms projecting from the globe cause the vapor to issue in such a direction that the reaction produces a rotary movement of the globe, just as the rotation of reaction water wheels is produced by outflowing water.

Cat. No. 244,887 U.S.N.M.

# Model of Dr. Denis Papin's Atmospheric Steam Engine, A. D. 1690. Deposited by the United States Department of the Interior.

The apparatus proposed by Dr. Papin consists of an open-topped metal cylinder fitted with a piston and piston rod. A small quantity of water is placed in the bottom of the cylinder and heated by a fire placed underneath until the steam generated forces the piston to rise to the top. The fire was then removed and the steam gradually condensed, forming a vacuum within the cylinder, and thus causing the piston to move downward by air pressure with such force as to enable it by the aid of a rope and overhead pulley to lift a weight.

Papin stated that a cylinder 2½ inches in diameter, if thus worked, could raise a weight of 60 pounds once a minute through a height equal to the stroke.

Cat. No. 244,888 U.S.N.M.

Copy of Drawing of Thomas Savery's "Fire Engine" in the Philosophical Transactions of the Royal Society, London, England, Volume 21, 1699.

In 1698 Thomas Savery patented an apparatus "for raising of water and occasioning motion to all sorts of mill works by the impellent force of fire." No drawing of the arrangement was deposited

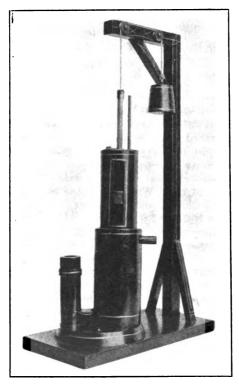


FIG. 4.—THE EARLIEST STEAM ENGINE WITH A PISTON, 1690.

with the patent, but in the following year a model of the machine was shown to the Royal Society and is illustrated in their Transactions.

The engine consists of a boiler and water receiver connected by a pipe permitting steam to pass from the boiler to the receiver. The receiver is provided with suction and delivery pipes and the corresponding valves. A hand-worked valve admitted steam to the receiver long enough to blow out all of the air. The valve was then closed and water from an overhead tank was turned on to the outside

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of the receiver which, acting as a surface condenser, condensed the steam, creating a partial vacuum within the receiver. This caused the water to be raised from the well or other reservoir through the suction pipe and into the receiver, where it assisted in the further condensation of the steam, which, in turn, resulted in the complete filling of the receiver with water. Steam was then turned into the receiver, and by its pressure forced the water out through the delivery pipe, the suction pipe in the meantime being closed by its non-return valve.

Cat. No. 180,351 U.S.N.M.

Photographic Copy of an Engraving, Published in 1719, of Newcomen's Engine, Erected Near Dudley Castle, Staffordshire, England, in 1712.

This is believed to be the first engine constructed by Newcomen, and it is interesting to note that the self-acting valve gear usually ascribed to the year 1718 was in use here six years before.

The engine consisted of a vertical open-topped cylinder fitted with a piston, which by chains was connected with one end of a beam. The other end of the beam was similarly connected with the vertical rods of a pump. The center of the beam was fitted with trunnions so that it could oscillate, and its ends were provided with arched heads so that the chains resting on them would remain vertical when the beam worked. The cylinder rested on top of the boiler, so that when a valve was open steam could enter the cylinder and allow the piston, which was being pulled up by the weight of the pump rods at the other end of the beam, to rise. When the piston had reached the top of the cylinder, the steam was shut off and cold water from an overhead supply was admitted in a jet at the bottom of the cylinder, which condensed the steam and formed a partial vacuum, whereupon the weight of the air forced the piston downwards. Upon completion of this downward stroke, the injection water was cut off. Steam was then admitted for the next upward stroke, during which the hot water at the bottom of the cylinder was discharged through an eduction pipe, terminating in a nonreturn valve, while the air that had come into the cylinder with the steam and injection water was blown out through a snifting valve, so called from the noise it made. (The Science Museum.)

The top of the cylinder was constantly flooded with water to prevent the entrance of air into the cylinder. Soft packing was used around the piston, for cylinders at that early date could not be machine bored. They were made of brass, cast as thin as possible to reduce the heating and cooling losses.

The steam and injection valves of the engine were at first worked by hand, but the desire of a boy, Humphrey Potter by name (so the story goes), to play, rather than operate the valves, inspired him to attach cords to the oscillating beam, whereby these valves could be opened and shut. The legend on the print gives the dimensions of the engine's cylinder as 21 inches in diameter and 7 feet 10 inches long, and of the boiler as 5 feet 6 inches in diameter and 6 feet 1 inch high, containing 13 hogsheads (700 gallons) of water. The pump work was in two lifts, each of 75 feet.

Cat. No. 180, 596 U.S.N.M.

Prints of James Watt's Steam-Jacketed Single-Acting Cylinder. Photomechanical Print from the Model in South Kensington Museum. Two Views.

The engine consists of an external cylinder closed at top and bottom, and an internal cylinder closed at top but opened at the bottom and fitted with a piston. The steam entering the latter would fill the part of the cylinder below the piston, also the space between the two cylinders, hence the inside cylinder is a steam-jacketed cylinder. A pipe connects the external cylinder to the separat coninder. A pipe connects the external cylinder to the separate condenser. Both the external and internal cylinders were made of tin plate roughly soldered up. Watt complained from first to last of its being leaky, and an experiment showed, as he expected, that it took as much steam from the boiler regardless of whether it was working or not. This model is presumed to be a very early one and may have been Watt's first attempt with a steam-jacketed cylinder kept hot and separate condenser kept cold.

Cat. No. 180,623 U.S.N.M.

# Print from a Model in South Kensington Museum of a Two-Cylinder Engine for Double Action.

In the patent of 1782 Watt states that there are various arrangements that may be made of the several engines.

A model in the South Kensington Museum is supposed to show a transition state, or an attempt to produce a double-acting engine, by two single-acting cylinders connected together by a chain over a pulley.

The print shows two single-acting vertical cylinders, their upper ends connected by a passage without valves, their pistons having single-acting valves opening upward, the eduction pipes entering the bottom of each cylinder and having conical valves. Within the eduction pipes is a small pipe terminating in a jet for injecting cold water, thereby converting it into a condenser. There are also air pumps for removing the water and air. Its action is as follows: While the steam in the left cylinder is being condensed, it is also entering the right cylinder, and, passing through the valve in its piston and the connecting passage between the upper end of the cylinders, it forces the left piston into the vacuum. When this piston arrives at the end of its stroke, the steam and injected water is reversed, a vacuum is formed under the right piston, and the steam enters the left cylinder, etc. The drum or pulley over which the chain passes is given a reciprocating motion which is communicated to a beam or connecting rod by a long pin on the drum.

Cat. No.180,627 U.S.N.M.

### Print from a Model in South Kensington Museum of James Watt's Double-Acting Beam Engine. Patented, 1782.

In this engine the chain heretofore connecting the piston rod to the beam is discarded and a parallel motion substituted, enabling the piston to push as well as pull the beam. The engine is also doubleacting, the steam and vacuum operating from opposite sides of the piston at the same time, both in the same direction, then both are reversed and the piston forced the other way.

Cat. No. 180,625 U.S.N.M.

## Print of James Watt's Semirotary and Rotary Engine. Patented, 1782. Three Views.

The semirotary engine has a piston fixed in a radial line to the shaft to be turned, and the cylinder fits the piston as it moves backward and forward through a considerable arc of the circle; fixed inside the cylinder at one part is a fixed stop or cylinder bottom for the steam to act against either way, as it acts against the piston in either one direction or the other. It was intended to let the reciprocating shaft act with a spur wheel on two racks attached to the pump rods. There was an unfinished model of this engine in the "Watt Room" at Heathfield Hall, England, no doubt made partly by Watt's own hands. In a letter of Watt, dated 27 September, 1782, he speaks of this model as having been made so far in 1765 or 1766.

The rotary engine has a piston fixed as an arm, and a radial line to the shaft to be turned. The cylinder of the engine fits the piston in its revolution, there being at one point a flap valve hinged to the inside of the cylinder, whilst its other end rests on the shaft so as to form a cylinder bottom or point of contact for the steam to act against when acting also against the piston. This flap valve is at a slight angle to a radial line, so that when the piston comes around it can heave it up so as to get past.

Cat. No. 180,621 U.S.N.M.

# Print from a Model in South Kensington Museum of James Watt's Bull Engine. Patented, 1782. Two Views.

This engine is supposed to take its name from an engineer by the name of Bull, who put up some engines in Cornwall. It is peculiar in that the piston rod passes out at the bottom of the cylinder through a stuffing box, the beam being placed below.

Cat. No. 180,626 U.S.N.M.

## Print of a Single-Acting Engine With a Balance Weight. Made According to James Watt's Patent, 1781.

The engine is single-acting and has an open-top cylinder, with air pump, condenser, and heavy balance weight on the connecting rod to give the impulse in one direction, whilst the piston on the other end of the beam, by means of the vacuum in the cylinder, gives the impulse in the other direction.

Cat. No. 180,616 U.S.N.M.

Print from a Model Showing Two Rotary Motions in Opposite Directions from the Same Engine. James Watt's Patent, 1784. Two Views.

A crosshead is secured to the beam of the engine from the ends of which two connecting rods convey the power to two separate shafts by "Sun and Planet" devices. As the eight-hand shaft is placed lower than the other, its connecting rod is jointed to a lower part of the beam so that both may have an equal motion throughout their entire revolution. This was probably intended for rolling metals for coining. The gearing by spur wheel carries the power to a mill for slitting.

Cat. No. 180,620 U.S.N.M.

Print of James Watt's "Crown Cam Motion," Patented, 1718. Adapted to a "Hoisting Engine." Two Views.

In this peculiar method a heavy crown cam is fixed on a vertical axis. Beneath it is a rocking frame having two friction rollers bearing on the inclined face of the cam on its opposite sides. The rocking frame is moved up and down from the beam of the engine. In all of the specifications of 1781 the engine was single-acting, and to produce power on the up and down strokes of the piston the connecting rod was heavily loaded.

Cat. No. 180,618 U.S.N.M.

Print of James Watt's "Sun and Planet" Engine. Patented, 1781.

In this invention the Planet is an internal geared wheel on the connecting rod and is held in gear by means of a friction roller on the lower end of the rod running around a fixed oval cam or guide block.

Cat. No. 180,619 U.S.N.M.

Print of James Watt's "Ladder Motion," with Two Fixed Guide Pins or Rollers. Patented, 1781.

The ladder consists of a long rack on the lower end of the connecting rod, as much like a ladder as possible, working against the teeth of a spur wheel fixed on the shaft. The bottom end of the connecting rod carries a friction roller working in a large opening in the guide plate, keeping the ladder always in gear with the spur wheel on the shaft. The fixed guide pins keep the ladder in gear the greater part of the up and down stroke whilst two projecting pins from the ladder, one at the top, another at the bottom, keep it in gear while passing the centers.

Cat. No. 180,617 U.S.N.M.

### Print of James Watt's Balance Wheel Rotative Engine.

### Watt says in his specification:

When steam is cut off at one-quarter the stroke there must be an equalizing arrangement to enable the piston to complete its stroke when pumping. For this purpose the upper end of the piston rod is a rack working into a toothed segment. On the other end of the beam, in place of the old horsehead meshing also into this segment, is a pinion secured to the shaft by a flywheel. At any motion of the beam at the early part of the stroke power is expended to give the flywheel motion, and the momentum thus gained is expended again at the last or weakest portion of the stroke, thus equalizing the power.

Cat. No. 180,630 U.S.N.M.

# Print which Shows the Converting of Reciprocating into Rotary Motion. James Watt, 1781.

It appears that J. Pickard in 1780 took out a patent for converting reciprocating into rotary motion by means of a "crank." It has been said that Watt would not attempt to make any terms with the man nor run the risk of a lawsuit. The use of pins in disks is represented. These were not called cranks in the specification, but " points of attachment of the connecting rods." Another sketch represents an eccentric on the shaft, the connecting rod embracing it and provided with three friction rollers or bearings. Another sketch represents the well-known "Sun and Planet" motion in which a spur wheel rigidly fixed on the end of the connecting rod gears into a spur wheel of equal diameter on the engine shaft and is held in gear by a projecting pin and friction wheel from the back of the planet wheel, traveling in a circular groove concentric with the shaft. A "Spur Planet" on the connecting rod and an internal geared disk on the shaft held in gear by a similar method to that shown in the preceding sketch is also represented. Cat. No. 180,615 U.S.N.M.

# Print of Steam Indicator Diagrams Taken with Watt's Indicator by Edward Cooper, Esq., August, 1840.

There is one view of a full-power diagram, showing the card and the record made by the pencil during one revolution of the engine. The card is first ruled with perpendicular lines dividing the length of its horizontal movement into 10 equal spaces, corresponding with the stroke of the piston divided into the same number of equal divisions. The black horizontal line, the "atmospheric line," shows the position of the pencil when not affected by the steam or vacuum pressure. The column of figures at the left of the diagram shows the pressure in pounds to the square inch; those above the atmospheric line indicate the steam pressure, while those below show the atmospheric or vacuum pressure. The irregular black line was made by

the pencil, that above the atmospheric line records the steam pressure during the forward stroke, and that below the line the vacuum pressure during the return stroke. The area inclosed between the perpendicular lines and the lines made by the pencil is computed to find the sum of the average steam and vacuum pressure to the square inch of the piston within that section, and the result in pounds and decimal parts placed below. The sum of these results is divided by ten to find the average pressure on the piston during its forward and return stroke. With this data, by quite simple rules the actual horsepower required from the engine to do the work at the time the diagram was taken is easily computed.

There is also a friction diagram taken to show the power necessary to run the engine and connecting machinery when not doing work.

Cat. No. 180,629 U.S.N.M.

### Print of James Watt's Steam Engine Indicator.

In this indicator the rocking beam is discarded and the spiral spring is placed above the piston, the cylinder being lengthened for this purpose. A pencil is attached to the upper end of the piston having an up and down motion only. The pencil rests upon a card secured to a light frame that has a horizontal motion corresponding to that of the piston in the engine's cylinder (though much less) given to it by a cord and weight.

Cat. No. 180,631 U.S.N.M.

### Prints from a Model of James Watt's Tilt Hammer.

The beam of the engine has its reciprocating motion converted into the rotary motion of a shaft by means of a connecting rod, crank, or other device. On the shaft is a flywheel and the cams for lifting the hammer. Two hammers are shown, one lifted by a cam under the "belly" of the helve like an ordinary forge hammer, except that the helve of the hammer is parallel with the shaft. The other hammer is lifted by another cam depressing the tail like an ordinary tilt hammer.

Cat. No. 180,624 U.S.N.M.

# Portion of Cylinder of a Jonathan Hornblower Steam Engine. Gift of the New Jersey Historical Society.

This cylinder is part of the first stem engine on the western continent, imported from England in 1753. Concerning it the Hon. Joseph P. Bradley, Associate Justice of the Supreme Court of the United States, wrote under date of September 20, 1875.

The steam engine (of which this is a portion of the cylinder) was the first ever erected on this continent. It was imported from England in the year 1753 by Col. John Schuyler for the purpose of pumping water from his copper mine

opposite Belleville, near Newark, New Jersey. The mine was rich in ore but had been worked as deep as hand and horse power could clear it of water. Col. Schuyler, having heard of the success with which steam engines (then called fire-engines) were used in the mines of Cornwall, determined to have one in his mine. He accordingly requested his London correspondents to procure an engine and to send out with it an engineer capable of putting it up and in operation. This was done in the year named, and Josiah Hornblower, a young man then in his twenty fifth year, was sent out to superintend it.

Mr. Hornblower's father, whose name was Joseph, had been engaged in the business of constructing engines in Cornwall from their introduction in the mines there, about 1740, and had been an engineer and engine builder from the first use of steam engines in the arts, about 1720. The engines constructed by him and his sons were the kind known as Newcomen's engines, or Cornish engines. That brought to America by Josiah was of this description. Watt had not then invented his separate condenser nor the use of high pressure. But it is generally conceded that for pumping purposes the Cornish engine has still no superior.

About 1760 the Schuyler mine was worked for several years by Mr. Horn-blower himself. The approach of the war in 1775 caused the operations to cease. Work was resumed, however, in 1792 and was carried on for several years by successive parties. It finally ceased altogether in this century, and the old engine was broken up and the materials disposed of. The boiler and large copper cylinder standing upright eight or ten feet high and as much in diameter, with a flat bottom and a dome-shaped top, was carried to Philadelphia. A portion of the clyinder was purchased by some person in Newark. In 1864 I met an old man named John Van Emburgh, then a hundred years old, who had worked on the engine when it was in operation in 1792. He described it very minutely and, I doubt not, accurately. It is from this description that I happened to know the kind of engine it was; although from the date of its construction and the use to which it was put, there could have been but little doubt on the subject.

Cat. No. 180,143 U.S.N.M.

### Model of R. F. Loper Steam Engine (Working). U. S. Patent, No. 4389, November 26, 1845. Transferred from United States Patent Office.

The engine is arranged to operate two parallel crankshafts in opposite directions and with equal velocities. A motion is brought about by means of a connecting rod extending from the steam crossheads to the two crank shafts, the center of vibration of the crossheads being centrally between the two.

Cat. No. 251,297 U.S.N.M.

# Model of John Ericsson Steam Engine. U. S. Patent, No. 6844, November 6, 1849. Transferred from United States Patent Office.

The engine is designed to use steam expansively. There are two vertical, single-acting beam engines placed side by side whose cranks are connected to the same shaft but 180 degrees apart, and whose cylinders are of different sizes. Steam is admitted to the smaller cylinder at the top and acts directly on the piston for a portion of its stroke, but is cut off at a given point and acts expansively for

the remainder. At the end of the stroke a slide valve opens and the steam passes the top of the larger cylinder where it acts expansively on the piston, pushing it downward. The size of this second cylinder is such that the steam is able to exert as great a force for the full stroke as it exerted in the first cylinder. At the same time that the steam is passing to the second cylinder a portion is directed through a suitable passage to the underside of the piston of the first cylinder, so that while the piston of the second cylinder is mov-

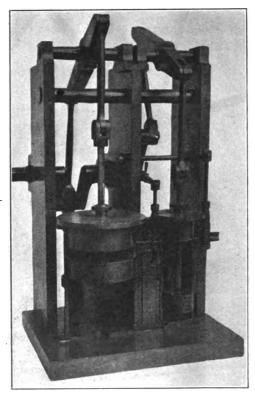


FIG. 5 .- ERICSSON STEAM ENGINE, 1849.

ing downward by the expansive force of the steam the piston of the first cylinder is balanced during its return motion by the pressure of steam on both sides of it, thus making available the full pressure of the steam on the piston of the larger cylinder.

The lower end of the second cylinder beneath the piston is in constant communication with the condenser. The upper end also communicates with the condenser by means of a valve-controlled passage which is opened when the piston reaches the end of its stroke and permits the exhaust of steam from the cylinder so that a vacuum is created above as well as below the piston, permitting

it to make its return motion in a vacuum while the piston of the first cylinder is being carried downward by direct steam pressure.

Cat. No. 251,299 U.S.N.M.

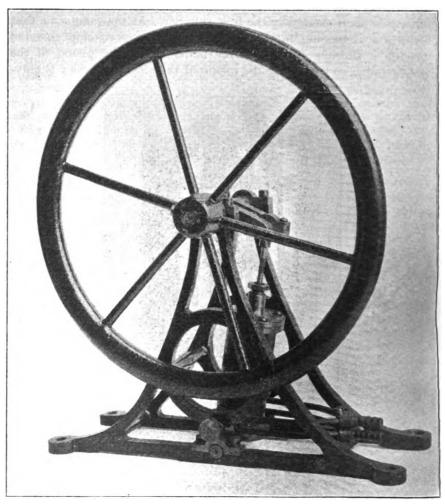


FIG. 6 .- SCHLARBAUM OSCILLATING STEAM ENGINE, 1868.

Model of H. Schlarbaum Oscillating Steam Engine. U. S. Patent, No. 39756, September 1, 1863. Transferred from United States Patent Office.

The engine is a high-pressure, double-acting one. The axis of the vertically oscillating cylinder is near the base, forming a part of the lower cover of the cylinder and beneath the steam and exhaust ports. On each side of the cylinder and at right angles with the axis of oscillation is a steel-lined surface from which steam ports run to the upper and lower parts of the cylinder. The steam and exhaust pipes, which branch off from trunk lines so as to extend to each side of the cylinder, terminate in a steel-lined head or block which fits closely to the steel surfaces mentioned above. The openings in these blocks are of the proper diameter and distance from each other, so that all steam connections are shut off when the piston is at the end of its stroke and open when it is in the middle of its stroke. The changes of steam are made without any movement of the steam-conducting headpieces, but by the movement of the cylinder alone.

Cat. No. 251,293 U.S.N.M.

Model of W. Sellers Oscillating Steam Engine. U. S. Patent, No. 127928, June 11, 1872. Transferred from United States Patent Office.

The engine is equipped with a curved link or arc, concave toward the axis of oscillation of the cylinder, which is provided with a

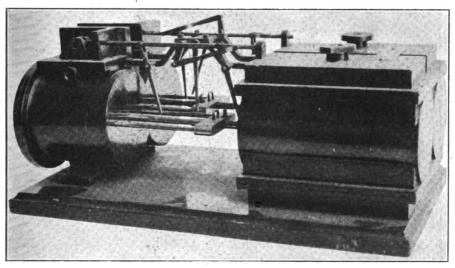


FIG. 7.-WORTHINGTON STEAM PUMP, 1859.

means of varying and adjusting the degree of its obliquity; an eccentric which operates this link; and a sliding block or die which transmits motion to the valve of the engine. The objects attained are, first, providing an improved means of operating the valve of the engine; and, second, providing an improved means of guiding the piston rod and diminishing the wear upon the stuffing box.

Cat. No. 251,296 U.S.N.M.

Model of H. R. Worthington Steam Pumping Engine. U. S. Patent, No. 24838, July 18, 1859. Transferred from United States Patent Office,

The engine consists of two direct-acting pumping engines so combined that the steam and exhaust valves of each engine govern the

motive power of the other, thereby insuring the constant action of at least one pump piston upon the water to be raised and relieving the action of the pump from shocks and concussions.

The attachments to bring this arrangement about are alike on both engines. A complete cycle is as follows:

When steam enters the cylinder of one of the engines its piston commences to move and at some fixed point in its stroke it actuates the steam and exhaust valves of the other engine through a series of

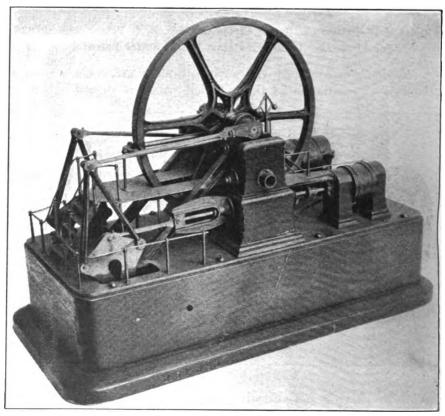


FIG. 8 .- CORLISS STEAM PUMP, 1879.

levers. Still going on, it completes its stroke and finally terminates its motion by closing its own valve by means of a stopping lever. Meanwhile the piston of the second engine, having been set in motion by the first, has commenced its own stroke. On its way it encounters and moves the valve of the first engine through a series of levers; continues to the end of its stroke, closing its own valve, and rests until again called upon to move by the first engine. Thus one piston is put in motion, proceeds on its stroke, actuates the valve of the other

engine, shuts its own valve, and stops with no power to move again until actuated by the operation of the other engine.

Cat. No. 251,300 U.S.N.M.

Model of George H. Corliss Steam Pumping Engine. U. S. Patent, No. 215803, May 27, 1879. Transferred from United States Patent Office.

The interesting feature of this engine is an oscillating lever having a fixed axis at one end and a connection with the crank and fly-

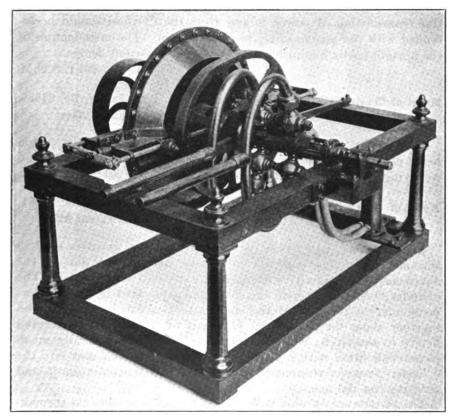


FIG. 9.-MILLER ROTARY ENGINE, 1859.

wheel at the other end which is in combination with a reciprocating pump piston or plunger connected to the above mentioned lever at a convenient point between its ends. It gives to the crank in its connection an increased stroke as compared with that of the pump.

A portion of the steam power applied to the pistons is directly utilized in working the pump plungers by means of a continuous piston rod which extends from the cylinder into and through the

pump and is connected by a link to the middle of an upright lever oscillating on an axis on its lower end and connected by a horizontal connecting rod to the crank. In working steam at the high rates of expansion indispensable to the attainment of the best economic results, there must be applied to the pistons during certain parts of the stroke an amount of steam power largely in excess of that required to overcome the nearly uniform resistance of the water pressure on the plungers. As, in the regular operation of the engine, this excess is immediately transmitted to the flywheel to be applied to the plungers before the termination of each stroke, it is important that this transmission of power to and from the flywheel should be attended with the least possible loss by friction. The introduction of the upright levers diminishes this loss in an important degree.

Cat. No. 251,291 U.S.N.M.

Model of Charles Miller's Rotary Steam Engine, U. S. Patent, No. 23852, May 3, 1859. Transferred from United States Patent Office.

A two-cylinder engine of the revolving-piston type, the piston being elliptical in shape, with the major axes 90 degrees apart and revolving on a central shaft.

Cat. No. 251,292 U.S.N.M.

Model of James Platt's Rotary Steam Engine, U. S. Patent, No. 34981, September 15, 1862. Transferred from United States Patent Office.

The engine is of that type in which the cylinder revolves about a stationary abutment head. Two pistons, one on each side of the abutment, work radially within and rotate with the cylinder. The cylinder is concentric with the shaft and is divided in a plane perpendicular to the axis of the shaft into two equal parts, secured together about the periphery. One half of the cylinder is secured firmly to the shaft, while the other half is bored centrally much larger and fitted with a stuffing box, through which and into the cylinder passes a stationary sleeve, inclosing the main shaft and carrying the abutment.

The pistons are parallel sided and are fitted into slots cut through the periphery of the cylinder but inclosed by piston boxes bolted to the outside of the cylinder. The piston rods, which work through stuffing boxes in the piston boxes, have crossheads attached to them to the ends of which are attached guide rods. One guide rod of each piston has attached to it two friction rollers which work on the inside and outside, respectively, of a laterally projecting rim of a stationary cam keyed to the sleeve surrounding the main shaft. This cam holds each piston stationary in relation to the cylinder and in contact with the edge of the abutment during half of its

revolution farthest from the abutment and draws it out far enough to pass the abutment previous to its arrival, and in, after passing.

Steam and exhaust passages are led to the cylinder through the sleeve inclosing the main shaft.

Cat. No. 251,294 U.S.N.M.

#### AIR AND INTERNAL COMBUSTION ENGINES.

The expansion of air upon being heated and its contraction on cooling has attracted the attention of many persons during the past

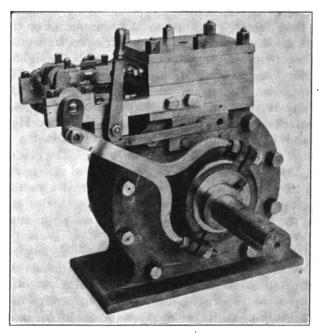


FIG. 10.-PLATT ROTARY ENGINE, 1862.

one hundred years, and has led to the invention of a variety of hotair engines. The earliest of these having real merit was patented in England in 1827 by Dr. R. Stirling. The engine consisted of two chambers filled with air and connected by pipes with each end of a cylinder whose piston received a reciprocating action by the alternate expansion and contraction of the air. In addition the engine was equipped with a regenerator which absorbed some of the heat of the air as it passed out of the cylinder and gave it out to the incoming air. In later improvements made by Stirling the air was compressed before heating, and an engine was designed so that the same air could be used over and over again. This attempt at making a theoretically perfect engine was more economical in fuel consumption than any double-acting steam engine of that time, but the

heavy expense in wear and tear and the burning out of parts counteracted its fuel efficiency.

The great restriction to the development of the hot-air engine has been the necessity of keeping the temperature low within the cylinder, with the result that its efficiency is limited.

John Ericsson of New York constructed an air engine in 1834 of simple design in which hot air admitted to a cylinder moved a piston while expanding down to atmospheric pressure. In 1852 Ericsson built some large engines to be used in propelling trans-Atlantic vessels. A ship was so equipped but never made an ocean trip other than from New York to Washington. For the reasons noted, large hot-air engines have since Ericsson's time been abandoned but small-powered engines are being made for light work.

The earliest internal-combustion engine was the gun. The use of gunpowder, however, as a means of obtaining mechanical power is of comparatively recent date, such experiments having been made during the latter part of the seventeenth century by Hautefeuille, Huygens, and Papin. Huygens in 1678-79 exploded a charge of gunpowder in the bottom of a vertical cylinder. The greater part of the air and of the gaseous products were expelled through nonreturn valves, but the remaining gas in cooling produced a partial vacuum below a piston, which then descended owing to the atmospheric pressure on the outside and in so doing did work by means of a cord over a pulley.

A period of over a hundred years ensued before any further experiments were made utilizing the explosion of inflammable gases. In 1794 an English inventor, R. Street, secured a patent, No. 1983, which involved the vaporizing of spirits of turpentine on a heated metal surface, mixing the vapor thus produced with air in a cylinder, firing the mixture by an outside flame, and driving a piston by the explosion produced. Another fifty years passed, when in 1844 one Stuart Perry of New York procured a United States patent for "an engine to be operated by the explosive mixtures of inflammable gases or vapors." Two years later a second patent was granted to Perry for improvements made on the original engine.

The first practical gas engine was developed in France by J. J. E. Lenoir and patented in 1860. Although it did not embody any new features, it was successful. To start the engine the fly-wheel was pulled over, thus moving the piston, which drew into the cylinder a mixture of gas and air through half its stroke. The gas was then exploded by an electric spark and moved the piston to the end of its stroke, the pressure meanwhile falling by cooling and expansion to that of the atmosphere when exhaust took place. In the return stroke the process was repeated, thus resembling a double-acting

steam engine and having a one-stroke cycle. The engine was water cooled. The electric spark was supplied by two Bunsen batteries and an induction coil, the circuit being completed at the correct intervals by contact pieces on an insulating disk on the crank shaft.

On June 17, 1873, a United States patent was issued jointly to L. C. Errani and R. Anders, of Belgium, for new improvements in dynamic machines which the inventors called "a motor without gas." The invention is of interest in that petroleum (presumably the lighter oils) is stipulated and used for the propelling force. The motor is, in general, similar to an ordinary steam engine, including a cylinder, reciprocating piston, crank and flywheel, and valve gear for operating through a cam a main valve connected with the cylinder. Shortly after Errani and Anders received their patent, a patent was granted to J. Hock, of Vienna, Austria, Patent No. 151129, May 19, 1874, for improvements on the Errani and Anders motor, which improvements resulted in the making of the first practically successful oil engine.

The gas and oil engines developed up to this time were of the non-compression type. They were likewise heavy and awkward and gave little power. But about the time that Hock obtained his patent, G. B. Brayton, of Boston, Mass., obtained a patent, No. 151468, June 2, 1874, for an oil engine which worked on a constant pressure but without any explosion. This appears to be the earliest compression engine to use oil.

Probably the greatest improvement made in the internal-combustion engine was the compression of the explosive mixture in the engine cylinder before ignition and the introduction of a practical engine working on the four-cycle stroke. Both of these steps were made by N. A. Otto, of Germany, and patented in the United States August 14, 1877, Patent No. 194047. The compression of the explosive was Otto's idea, but the four-cycle stroke, it is now conceded, was proposed by A. Beau de Rochas, of France, in a treatise published in 1862, but it remained for Otto to develop it practically. Although Otto developed and patented his ideas to apply to the gas engine, the advantages were soon recognized and almost immediately applied to the oil engine and are still so applied, further improvements being mainly in the direction of higher compression.

Shortly after the introduction of the Otto gas engine, a motor of this type was brought out operated by an inflammable vapor produced by passing air on its way to the cylinder through the light oil known as gasoline. A further supply of gasoline was subsequently drawn into the cylinder to form the required explosive mixture which was then compressed and fired. The Spiel petroleum engine followed and was the first Otto cycle motor which dispensed with an inde-

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pendent vaporizing apparatus. A light oil of a specific gravity of not over 0.725 was injected directly into the cylinder on the suction stroke by means of a force pump. Upon entering it formed a spray, was mixed with air, vaporized, compressed, and ignited as in the gas engine.

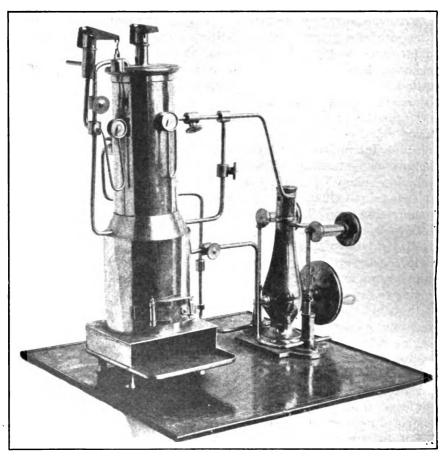


FIG. 11. - WHITING AIR AND STEAM ENGINE, 1879.

### Model of James M. Whiting Air and Steam Engine, U. S. Patent, No. 217757, July 22, 1879. Transferred from United States Patent Office.

The engine consists of a tubular steam boiler of ordinary construction, having above it a hollow cylinder which is connected on one side and at the top by pipes from the boiler. There are also other pipe connections from the cylinder to an air pump and to the valve opposite the engine proper.

The cylinder is so constructed and connected with the boiler and encased in a jacket that the escaping heat may be utilized in keeping

the cylinder hot. The steam and air are not superheated after being mixed in the cylinder, but the air is heated, expanded, and mixed with the steam within the heated cylinder and acts directly upon the piston of the engine. It is claimed that by heating and expanding the air and mixing it with the steam all at the same time a large amount of air may be used without condensing the steam and without losing any of the effective power resulting from the sudden expansion of the air.

The steam generated in the boiler may be used to act directly upon the engine or may be first sent through the preheated cylinder and mixed with air and from there proceed to the engine.

Cat. No. 251.285 U.S.N.M.

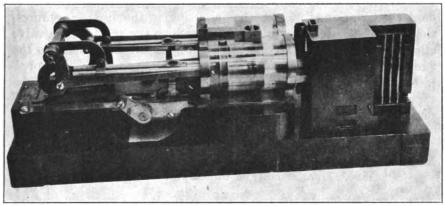


FIG. 12.-ERICSSON AIR ENGINE, 1855.

#### Model of John Ericsson Air Engine. U. S. Patent, No. 13348, 1855. Transferred from United States Patent Office.

The engine is single acting and consists of two cylinders open at one end connected by a crank shaft, the two cranks being 180 degrees apart. Each cylinder has two pistons, an inner or "supply" piston and an outer or "working" piston. The rods of the former pass through a stuffing box in the latter and are operated through a series of levers, rollers, and cams by the crank shaft. The "working" piston has two wrist pins on either side of the stuffing box and connected through suitable levers to the crank shaft.

Above the cylinders is a "regenerator" consisting of a box filled with coiled tubing through which the cold compressed air from the cylinder passes on its way to the heating coils and around which the hot air, after doing its work in the cylinders, is caused to circulate.

When the pistons of one cylinder are at the extremity of their outward stroke, those of the other cylinder are about to start on their outward stroke by the force of expansion of the hot air admitted

from the heater. The outward movement of the pistons of cylinder No. 2 causes the pistons of cylinder No. 1 to start their instroke. The "working" piston moves slowly but the "supply" piston, through its mechanical connections to the crank shaft, moves rapidly and in so doing draws cold air after it through an open valve in the "working" piston, and drives expanded hot air ahead of it through the exhaust valve and into the "regenerator." When it reaches the end of its stroke the exhaust valve closes and the "working" piston continuing inward compresses the cold air ahead of it.

As the "working" piston approaches the "supply" piston and about reaches the end of its stroke an intake valve opens, admitting hot air from the heater. The expansion of this air in the cylinder head acting against the "supply" piston starts it on its outstroke to meet the "working" piston, thus assisting in the further compression of the cold air for an instant, after which the opening of a valve allows the compressed air to pass out of the cylinder and into the "regenerator" tubes. At the same time a valve opens in the "supply" piston, admitting hot air to the area between the two pistons, whose expansive force moves the "working" piston outward—the "supply" piston following by the action of the levers to which it is attached. Cat. No. 251,279 U.S.N.M.

### Model of John Ericsson Air Engine. U. S. Patent, No. 266052, March 30, 1880. Transferred from United States Patent Office.

The cylinder of the engine is open at the upper end and contains two pistons designated as the "working" piston and the "exchange" piston. The lower part of the cylinder is closed and is intended to be heated by any suitable type of burner or fireplace. The "working" piston, which is in the upper part of the cylinder, is packed so as to work air-tight. The "exchange" piston, which is of considerable length in an axial direction, is so much smaller than the cylinder that an annular space for the free passage of air is left between its exterior and the interior wall of the cylinder. This piston is hollow. the upper half being filled with cotton or other fibrous material, which in turn is separated from the lower end of the piston by a layer of charcoal or other nonconducting material so as to protect the cotton from the heat to which the bottom part of the piston is subjected. The "working" piston is connected by a hollow rod and short side links with a beam above the cylinder, the connection being at a short distance from the fixed center of oscillation of the beam.

The beam is connected at a much greater distance from the other side of the center by a connecting rod with a short crank on the main shaft of the engine. This short crank is also connected by a rod with one arm of a "bell" crank lever which has a fixed center of oscilla-

tion. The other arm is connected by arched side rods on opposite sides of the cylinder by an arched yoke. The piston rod of the "exchange" piston passes through the arched rods before mentioned.

The movement of the pistons is as follows: During the upward movement of the "exchange" piston the cool air from the upper part of the cylinder will be transferred by this piston through the annular space between it and the cylinder wall to the bottom and lower part of the cylinder. The air so transferred, becoming heated, expands

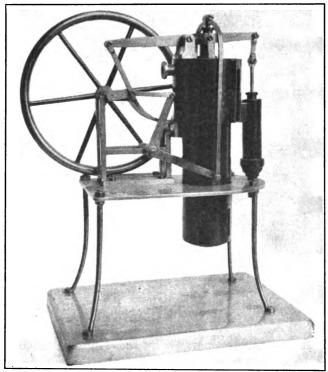


FIG. 13.-ERICSSON AIR ENGINE, 1880.

in the lower part of the cylinder, and its expansion causes it to force the "working" piston upward—the movement of the "exchange" piston being about three-fourths completed before the "working" piston commences its upward movement—and when the "working" piston has nearly completed the working stroke the "exchange" piston begins to descend and forces the hot air back from the lower to the upper or cooler part of the cylinder, completing its stroke by the time the "working" piston has made about one-third of its return stroke. The "working" piston is actuated by the air which is confined in the cylinder and which is caused to be heated and cooled alternately by the peculiar motion of the "exchange" piston. The

water in a water jacket surrounding the upper portion of the cylinder is kept in circulation by a pump whose piston is connected with the main beam on the same side of the center of oscillation as the "working" piston.

By the arrangement of the crank shaft, the centers of motion of the beam and bell-crank lever, and their individual connections a long crank with a short stroke of the "working" piston is obtained. Cat. No. 251,286 U.S.N.M.

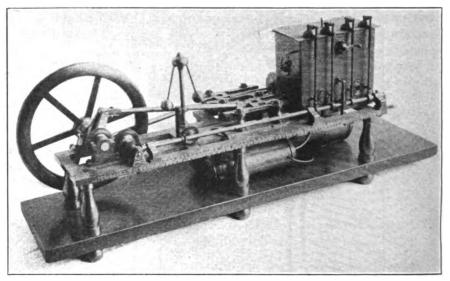


FIG. 14.—PERRY GAS ENGINE, 1846.

Model of Stuart Perry Gas Engine. U. S. Patent, No. 4800, October 7, 1846. Transferred from United States Patent Office.

This engine is "to be operated by the explosive mixtures of inflammable gases or vapors," the particular explosive mixture used, however, being that of air and gas generated from spirits of turpentine. The gas generator is part of the equipment and is situated within a water tank which also surrounds the engine cylinder.

Cylindrical tanks beneath the engine bed contain air under pressure filled at first by a hand pump, but after the engine is in motion by a pump operated by the engine. To operate the engine it is first necessary to heat the water in the tank by some outside means in order to vaporize the turpentine. Gas having been generated, the extraneous supply of heat is removed and air from the air-supply tanks is admitted into a valve box located above the retort. Through a slide valve some of this air enters the retort, is mixed with the gas, and exits through suitable apertures to passages leading to opposite ends of the cylinder. The admission of the gas to the

cylinder through these intakes is controlled by valves operated by rods, which in turn are operated by appropriate cams on a shaft receiving motion from the crankshaft. The exhaust is in the under side of the cylinder.

The opening of the intake valve permits the gas to pass along the intake passage to the cylinder. At one point in its travel the gas passes over a hot platinum cup previously heated by the burning of a portion of the gas obtained through a by-pass from the valve box. The red-hot platinum ignites the gas and the resultant expansion forces the piston to the opposite end of the cylinder. Upon reaching the end of the stroke, the intake valve at this end of the cylinder opens, admits gas which is similarly ignited, and forces the piston back. Such is the cycle. The water in the tank serves a variety of purposes. It keeps the engine cylinder sufficiently cool for efficient operation—its temperature, however, is sufficiently high to vaporize the turpentine—and it lubricates the piston rod and prevents it from being overheated. Another interesting feature of the engine was the firing of the charge of gas by heated platinum, rather than a naked flame, as practiced by earlier inventors.

Cat. No. 251,278 U.S.N.M.

### Model of G. B. Brayton Gas Engine. U. S. Patent, No. 125166, April 2, 1872. Transferred from United States Patent Office.

The motive power for the engine is obtained by burning a mixture of air and illuminating gas. The engine consists of a vertical cylinder having a double-headed piston. Upon the down stroke of the piston a quantity of gas and air mixed is drawn into the upper part of the cylinder, and upon the upstroke this same gas is forced out of the cylinder under pressure into a receiving tank, which acts as the supply tank for the gas to be used as the motive power.

The pressure maintained in the supply tank is at least 60 pounds to the square inch. In the bottom of the cylinder below the reach of the down-stroke of the piston there are placed a number of wire gauze diaphragms. They serve to guard the passages through which the gas is supplied to the engine and cut off the flame after the gas has been ignited from the supply which is flowing from the tank when the valve connection is open. This valve is controlled by means of a revolving cam on the main shaft. The design of the cam determines the length of time that the valve remains open, a spring causing it to close upon the instant that the cam ceases to hold it open. A constant flame of gas is maintained upon the upper surface of the wire gauze diaphragms which serve to ignite each charge of the gas as soon as it passes through the diaphragms. Consequently, upon ignition the steady expansion exerts a true pressure upon the piston

and causes it to move upward. Upon completion of its upward stroke the momentum of the balance wheel, which is connected by means of a common crank and links to the piston, causes the piston to descend. In its descent a cam on the main shaft, acting upon a lever, opens an exhaust valve.

Cat. No. 251,280 U.S.N.M.

Model of Errani and Anders Petroleum Dynamic Engine, U. S. Patent, No. 140021, June 17, 1873. Transferred from United States Patent Office.

The engine resembles an ordinary steam engine whose piston, however, is actuated by the expansive force resulting from the ignition at the beginning of the "outstroke" of a mixture of petroleum and

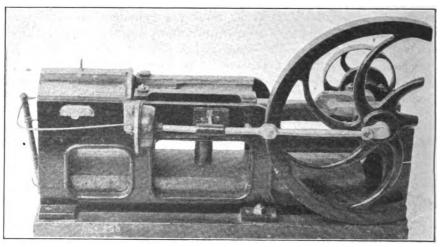


FIG. 15.-ERRANI AND ANDERS OIL ENGINE, 1873.

air sprayed into the cylinder through an aperture in its head. The oil-spraying device operates on the same principle as that of the household atomizer and cologne spray. Beneath the engine is an oil tank from the bottom of which protrudes a vertical tube. This is surrounded by an air chamber whose upper end terminates in a nozzle opposite the aperature in the cylinder head. Blasts of air obtained from a rubber bulb intermittently compressed by the action of a plunger operated by a crank on the main shaft fill the air chamber, forcing the oil up the tube and out of the nozzle together with air into the engine cylinder. Upon the ignition of the oil by an electric spark expansion moves the piston forward to the end of its stroke, and the impetus thus given to the flywheel returns the piston to its normal position ready for a repetition of operations. The quantity of oil sprayed into the cylinder is regulated by a cock in the charging pipe of the oil tank. When this cock is open all of the air forced into the air chamber by the bulb compressor passes out of the oil tank

through the cock and exerts no pressure on the oil which, therefore, can not rise to the nozzle, and the engine stops.

Cat. No. 251,283 U.S. N.M.

## Model of Julius Hock Petroleum Engine. U. S. Patent, No. 151129, May 19, 1874. Transferred from United States Patent Office.

This is one of the earliest types of internal combustion engines in which liquid petroleum is sprayed into the cylinder and ignited. Oil

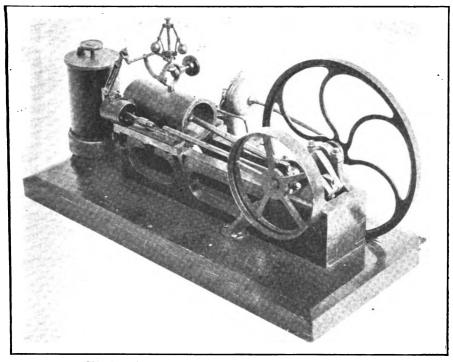


FIG. 16.-HOCK OIL ENGINE. THE FIRST SUCCESSFUL ONE, 1874.

is supplied to the motor from an air-tight tank, the quantity being regulated by raising or lowering a plunger immersed in the oil. The cylinder end of this oil supply pipe is nozzle-shaped and is screwed into the cylinder head. Arranged in the cylinder head also are one or more air nozzles directed across the path of the oil and supplied with air from a bulb similar to that on the Errani and Anders motor. The mixture of oil and air is ignited by a flame of gas directed horizontally into the cylinder through a hole in its head. The gas, which is naphtha, is obtained from a generator attached to the bulb compressor, which generator consists of a tank containing petroleum. Air from the compressor is forced through the petroleum, yielding a mixture of naphtha and carbonized air. A portion of this

gas passes directly to the engine cylinder at intervals and the balance is stored in a tank to supply a gas burner whose flame is in the path of the petroleum igniting gas, and ignites it as it passes into the cylinder.

The engine cycle is as follows: The gas burner is lighted and the flywheel turned. During the forward motion of the engine piston a small amount of petroleum is admitted and atomized by air. After the piston has moved a quarter stroke the air bulb is compressed, causing a blast of carbonized air and gas to be emitted from the gen-

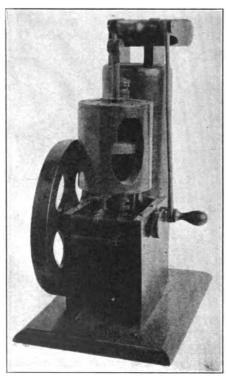


FIG. 17.—BRAYTON OIL ENGINE. OIL UNDER PRESSURE, 1874.

erator. The mixture exits through a nozzle, is immediately ignited by the flame of the gas burner, proceeds into the cylinder, and ignites the petroleum vapor within. The pressure created by the resulting combustion closes all valves and forces the piston forward to the end of its stroke and the impetus of the flywheel brings the piston back ready for the next charge.

Cat. No. 251,282 U.S.N.M.

Model of G. B. Brayton Oil Engine. U. S. Patent, No. 151468, June 2, 1874. Transferred from United States Patent Office.

The engine consists of a vertical cylinder, single acting. On the crank shaft are two cams which operate the intake and exhaust

valves located in the cylinder head. To the rear of the engine proper is an air tank with air under pressure as great as 60 pounds a square inch, maintained by the engine itself. A suitable valve regulates the amount of air passing out of the tank to the intake pipe. Surrounding the intake is an annular space stuffed with some absorbent material which is saturated at each revolution with a prescribed quantity of oil, the saturation being accomplished by a suction and force pump operated by a cam and connecting rod on the main shaft.

Above the intake pipe and the surrounding annular chamber is a circular opening in which is placed a wire gauze diaphragm on the upper surface of which gas is constantly burning, the gas being supplied from an outside source.

To operate the engine the gas above the wire diaphragm is ignited and the intake valve opened. Air from the tank enters the intake pipe and in passing upward permeates the absorbent material charged with oil through holes in the walls of the intake pipe. The oil now vaporized and mixed with air continues upward, passes through the wire-gauze diaphragm, and is ignited. The resultant expansion moves the piston upward and the impetus of the flywheel returns it. Should the temperature of the air be too low to vaporize the oil, its pressure is sufficient to drive the oil out of the absorbent in the form of a fine spray which upon striking the wire-gauze diaphragm is instantly vaporized, mixes with air, and is ignited as under normal conditions.

Cat. No. 251, 281 U.S.N.M.

## Model of N. A. Otto Gasoline Engine. U. S. Patent, No. 194047, August 14, 1877. Transferred from United States Patent Office.

In gas-motor engines constructed before the invention of Doctor Otto, an explosive mixture of combustible gas and air was introduced into the engine cylinder where it was ignited, resulting in a sudden development of heat and expansion of the gases. A great portion of the useful effect was lost, however, by the absorption of heat, because no special provision was made for allowing the gases to expand rapidly. In the Otto engine, however, an intimate mixture of combustible gas or vapor and air is introduced into the cylinder, together with a separate charge of air or gas that may or may not support combustibles, in such a manner and in such proportions, that the particles of the combustible gaseous mixture are more or less dispersed in an isolated condition in the air or other gas, so that on ignition, instead of an explosion ensuing, the flame will be communicated gradually from one combustible particle to another, thereby effecting a gradual development of heat and a corresponding gradual expansion of the gases which will enable the motive power so produced to be utilized in the most effective manner.

The engine is single-acting and when exerting its full power makes one explosion or working stroke in every four strokes. Assuming the piston to be at the end of its instroke and about to be moved through its outstroke by the momentum of a flywheel, a slide valve opens to admit air into the cylinder. As the outstroke proceeds, the air supply is cut off, and the combustible gas intimately mixed with air is drawn in until the piston has arrived at the end of its outstroke. The gas port then closes and the piston is caused, by the momentum of the flywheel, to perform its instroke, whereby the charge of gaseous mixture and air that filled the cylinder at atmospheric pressure will be compressed. About the time for the beginning of the second out-

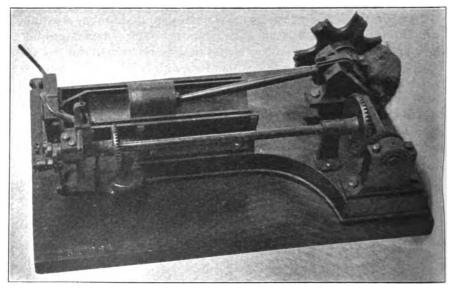


FIG. 18.—OTTO GASOLINE ENGINE. THE FIRST FOUR-CYCLE MOTOR, 1877.

stroke the gas is ignited and the gradual expansion of the gases causes the piston to complete its second outstroke. The second instroke then expels the products of combustion through an exhaust valve which remains open during this second instroke. The next outward stroke then commences a fresh cycle by taking in a new charge of air and gas.

By compressing the charge before firing it, nearly double the amount of air that otherwise would be permissible can be present in the mixture without preventing its being ignited, this additional cushion moderating the violence of the explosion and giving a more sustained pressure during the working stroke.

The cylinder is water-jacketed and the gas and air are admitted by a slide valve which serves also as an igniting valve, carrying a pocket of flame from an external light to a small port. The exhaust valve is of the drop type and is placed at the side of the cylinder. Both valves are actuated by a shaft driven by gearing at one-half the speed of the crank shaft. The speed of the engine is regulated by a centrifugal governor which, when the normal speed is exceeded, prevents the admission of gas so that no explosions take place until the speed has fallen to the prescribed limit. The engine may be arranged

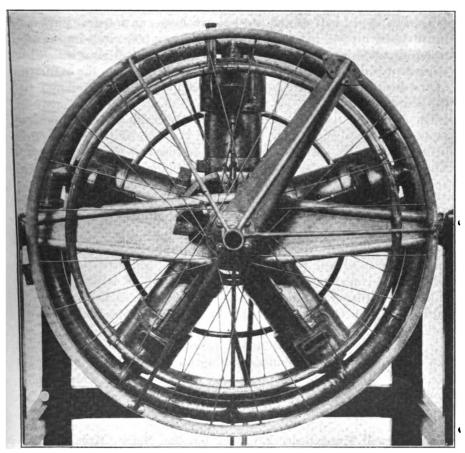


FIG. 19.-LANGLEY AERODROME ENGINE, 1901.

to be double-acting by providing the requisite valve gear for each end of the cylinder.

Cat. No. 251, 284 U.S.N.M.

Five-cylinder Water-cooled Gasoline Motor. Made in the Smithsonian Institution Shops by Charles M. Manly for the full-size Langley Aerodrome, 1901.

This four-cycle engine has stationary cylinders arranged radially on a central drum. They are made of seamless steel tubing, lined with cast-iron liners one-sixteenth of an inch thick shrunk into them. The combustion chambers entering the side of each cylinder near the top are turned out of solid steel forgings and secured to the cylinders by brazing.

All five piston rods operate on one crank pin. One of these rods is formed of a steel forging terminating in a sleeve which encircles the crank pin and is provided with a bronze lining in order to insure a proper bearing surface between the connecting rod and the crank pin. The upper half of this steel sleeve forms an integral part of the main connecting rod and is rounded off to a true circle on its exterior circumference except at the point where the rod joins it. The other four rods terminate in bronze shoes which bear on the exterior of the steel sleeve and are held in contact by cone nuts threaded to the sleeve and locked.

On one side of the crank shaft and near the crank arm is a doublepointed cam bearing on the exterior of the hub of the drum and driven by suitable gears at one-fourth the speed of the crank shaft. The cam operates the exhaust valves of all cylinders through rollers and punch rods in contact with the exhaust-valve stems.

The gasoline manifold consists of a tube bent to a circle and having five branch tubes each leading to one of the automatic inlet valves which fits removable cast-iron seats fastened in the upper part of each combustion chamber. The cooling water is led to the cylinder jackets on the starboard side through a circular tube connected by a pipe with a centrifugal pump. The hot water manifold is likewise circular and situated on the port side. The water is led from the jackets through the manifold and through two connections to two radiators.

The total weight of the engine is approximately 124 pounds, and the entire power plant including cooling water, carbureter, batteries, etc., weighs less than five pounds to the horsepower. Maximum power developed was 52 horsepower at 950 revolutions per minute.

Cat. No. 248,651 U.S.N.M.

# Adams-Farwell Five-cylinder Revolving Gasoline Motor. Made by The Adams Co. Presented by the Gyro Motor Co.

This is a four-cycle air-cooled motor with the cylinders bolted together and revolving around a vertical crank shaft which is keyed to a stationary base. The pistons are connected to the same crank pin, which is part of the crank shaft, so that the pistons can travel only in a perfect circle about their common center. The circle described by the pistons being eccentric to that of the cylinders, the pistons approach and recede from the cylinder heads. The position of the cylinders in relation to each other permits the use of a single throw crank and also makes it possible to operate five valve rods from

one cam, each rod operating two valves. The valves closing outwardly are held shut by centrifugal force, which also opens the inlet valve by its action on the valve rods. No throttle control is used, but the control consists in regulating the closing of the inlet valve so as to retain only the required charge of gasoline in the cylinder, allowing the balance of the gasoline to be drawn in by the next cylinder.

The cylinders are 4½-inch bore and 3½-inch stroke, developing 36 horsepower at 1,500 revolutions a minute, the maximum speed. Total weight is about 97 pounds, equal to about 2.7 pounds to the horsepower.

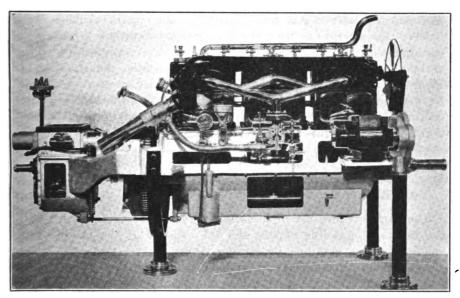


FIG. 20.-HAYNES SIX-CYLINDER AUTOMOBILE ENGINE, 1914.

This motor was used by Mr. Emile Berliner, of Washington City, in helicopter experiments during the years 1907-8.

Cat. No. 276,602 U.S.N.M.

### Six-Cylinder Gasoline Motor. Made and Presented by the Haynes Automobile Co., 1914.

This is an example of the "power plant" designed for use in certain of the automobiles built by the Haynes Co. in 1914. Selected portions of the motor have been cut away so as to show the working parts in operative relation.

The engine has six water-jacketed L-head cylinders, 4½-inch bore and 5½-inch stroke, cast in pairs and bolted to the crank case. The intake and exhaust valves are on the same side of the cylinders, the

valves being of the poppet type operated by a cam shaft geared to the crank shaft. The oiling system is splash and gravity feed to the main bearings and idler gear and also a constant feed to the oil basins in the crank case. An oil pump of the plunger type operated by an eccentric on the cam shaft circulates the oil. The motor is equipped with the Leece-Neville electric starting and lighting system, composed of a generator, motor, storage battery, and starting control, operated through the clutch pedal. It is also fitted with the Vulcan electric gear shift, operated by a push-button switch. The buttons control the operation of a set of electromagnets, one for each of the three forward speeds and one for the reverse. To the clutch pedal is connected a mechanical neutral device and a small mechanical master switch which completes the circuit to the storage battery for energizing the electromagnets. Ignition is obtained through a high-tension magneto geared to the crank shaft. carbureter is of the Stromberg make, whose inlet manifold is 14 inches in diameter. The gasoline feed is under pressure supplied by a hand pump and mechanical air pump on the motor. cooling water is circulated by a centrifugal pump geared to the crank shaft. Weight is 1,000 pounds, horsepower 65.

Cat. No. 283,279 U.S.N.M.

## Single-Cylinder Unit of Sleeve-Valve Gasoline Engine, 1921. Sectioned and Hand Operated. Gift of Willys-Overland Co., Toledo, Ohio.

The particular feature of this engine is that the regulation of both the intake of gasoline vapors and the exhaust of the products of combustion are obtained by sliding sleeve valves—two cylindrical sleeves which glide silently up and down between the cylinder wall and the piston, one working within the other. Slotted openings in these sleeves register with each other and with the cylinder ports at the proper intervals, forming large passages for the intake and exhaust gases. In practically all other respects the engine has much in common with the generally used poppet-valve type of engine.

Each sleeve is raised and lowered by a connecting rod from an eccentric shaft which, in turn, is operated on the same principle as a cam shaft in a poppet-valve engine.

The engine is of the four-cycle type, that is, the piston makes four strokes—two up and two down—for every explosion that takes place. These strokes in order and operation are:

1. Intake.—During the first downward stroke of the piston the two sleeve-valve openings on the carbureter side, come opposite each other and at the same time opposite the opening in the intake manifold. Through this unobstructed opening gasoline vapor is drawn into the combustion chamber.

- 2. Compression.—When the intake or downward stroke is complete, the valve openings have moved past each other and past the intake manifold opening—in other words, the ports have closed, and the upward stroke of the piston compresses the gasoline vapor. This compression continues until the piston reaches the limit of its upward travel when—
- 3. Power.—At this moment a spark occurs at the spark-plug points, situated directly above the center of the piston, and the expansion of the ignited gasoline vapor forces the piston downward, turning the crankshaft.
- 4. Exhaust.—The momentum of the flywheel causes the crankshaft to continue to turn, and again forces the piston upward. During this upward stroke the openings in the sleeve valves on the exhaust side gradually come opposite each other and opposite the cylinder port opening into the exhaust manifold and the burnt gas is forced out of the combustion chamber.

The sleeve-valve gasoline engine was developed by Charles Y. Knight, of Chicago, Ill., and was patented in 1903. An engine was first installed in 1905 in an automobile built in the factory of the Garford Co., Elyria, Ohio. The following year it was adopted by the Daimler Automobile Co., of England; later by Panhard, of France; Mercedes, of Germany; and Minerva, of Belgium; and rather recently by Willys and Stearns, of the United States.

Cat. No. 307,212 U.S.N.M.

### Four-Cylinder Gasoline Automobile Engine, 1921. Sectioned and Operated. Made and Presented by The Autocar Co.

This engine is the most recent design of The Autocar Co. for use in its automobile trucks. It is of four-cycle, poppet-valve type, water-cooled, with the cylinders cast in block with removable cylinder head. On the left-hand side of the engine are located the water pump, magneto, oil gauge, and oil-filler cap; and on the right-hand side, the carbureter, governor, and valve adjustments. The dimensions of the cylinders are 41-inch bore and 51-inch stroke, giving a horsepower of 28.9 (A. L. A. M. rating). The crank shaft is counterbalanced and mounted on two annular ball bearings and has no center bearing; the front bearing is 100 per cent oversize, and the rear bearing twice the size of the front, so as to carry the additional weight of the flywheel. This is a departure from general design, for, although ball bearings have been considered the ideal bearings for crank shaft mountings, it was difficult to maintain the alignment of the pistons on account of the whip or spring of the crank shaft when running at high speed. By use of a short crank shaft, due to block cylinder cast-

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ing and the elimination of any center bearing coupled with the counter balancing of the crank shaft, these difficulties are reduced to a minimum, and the crank shaft is kept true at any engine speed without distortion.

Another feature of the engine is the lubrication system. The oil is circulated by a gear pump driven from the cam shaft and located inside the lower engine pan. The oil is retained in a reservoir in the bottom of the crank case, where it is kept cool by the current of air continually passing around it. From this the oil is drawn by the

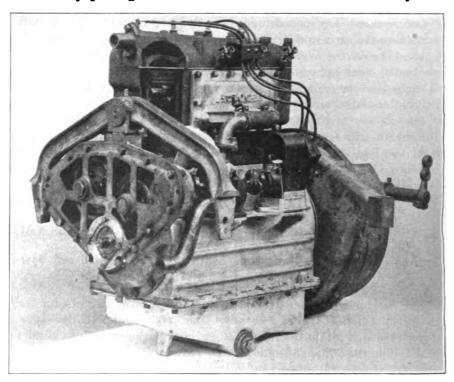


FIG. 21.—FOUR-CYLINDER GASOLINE AUTOMOBILE ENGINE, 1921.

gear pump through a heavy double strainer and forced under pressure to four standpipes, one directly beneath the center of each connecting-rod bearing. Each standpipe has a hole drilled on either side near the top, and at slow engine speeds oil flows out of these holes into a small cup-shaped pan secured to the standpipe beneath the oil holes. Inserted in the bottom half of each connecting-rod cap are two tubes extending inwardly to the connecting-rod bearings and of such a length and so spaced that when the connecting-rod cap is at its lowest position the tubes touch the oil in the cup-shaped pan and draw a small quantity up to the bearings. As the engine speed is in-

creased, a large quantity of oil is forced through the standpipes and into the cup-shaped pans, raising the oil level in the pan. As the engine speed increases, the oil streams from the standpipes are enlarged, and as the tubes in the connecting-rod bearing now cut through the increased oil streams, the result is an automatic elevation of the oil line, always in proportion to the increased speed.

The ball bearings, cylinder walls, cam shaft, valve gear, and other internal parts of the engine are lubricated by the splash derived from the tubes, while the wrist pins are lubricated by oil scraped from the cylinder walls and led through the oil passage to the piston-pin bearings.

The water circulation is obtained with a centrifugal pump. The ignition system consists of a Bosch high-tension magneto, a wire to each spark plug, and a wire to the switch. The engine is equipped with a Stromberg carbureter. A governor is attached to regulate the speed of the motor. It is operated by a shaft, which is driven by the engine cam shaft and governs the engine speed to prevent the racing of the engine in low gears or when declutched.

Cat. No. 307,254 U.S.N.M.

MOTOR ACCESSORIES.

Stearns and Hodgson Steam Engine Governor. U. S. Patent No. 9236, August 31, 1852. Transferred from United States Patent Office.

The apparatus consists of two weighted arms to the upper extremities of which are secured toothed quadrants working in a cylindrical rack placed in the main spindle of the governor in an opening sufficiently long to allow the rack to have a reciprocal motion equal to the demand of the valve which it may govern. When set in motion, the arms and their weights recede from the spindle by the centrifugal force given them, and thereby cause the toothed quadrants to operate on the cylindrical rack, which produces a reciprocal motion without the intervention of pins, levers, or connecting links.

Cat. No. 251,287 U.S.N.M.

Charles Porter Steam Engine Governor. U. S. Patent, No. 20,894, July 13, 1858. Transferred from United States Patent Office.

The apparatus is a ball-and-arm type of centrifugal governor, light in weight and driven at a high velocity. It is equipped with a counterpoise of a weight much greater than the aggregate of the balls and arms and sufficient to balance the centrifugal force developed.

Cat. No. 251,289 U.S.N.M.

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## D. A. Woodberry Automatic Steam Cut-off. U. S. Patent No. 107746, September 27, 1870. Transferred from the United States Patent Office.

The apparatus consists of a main eccentric swung from an axis upon a hub fixed to the crankshaft or upon an arm of the flywheel and adjusted laterally by means of an auxiliary eccentric. governor weights are firmly secured to springs which are in turn secured to an arm of the flywheel. The governor weights are hinged to links which at their opposite ends are attached to two arms of the auxiliary eccentric. When the crank shaft is put in motion, the centrifugal force of the weights will swing them outward partly revolving the auxiliary eccentric whereby the throw of the main eccentric is reduced and the valve caused to cut off sooner. If the motion of the crank shaft ceases or slows up, the weights produce an opposite effect upon the eccentric and valve, thus correcting any variation of speed in the engine. The arrangement of the weights is such that they precede their points of suspension in the direction of motion, and while at rest they lie near the crank shaft. By this means the liability of the weights to be thrown outward by their inertia when the engine is started suddenly, is avoided. Cat. No. 251,290 U.S.N.M.

# Internal-Combustion Engine Magneto Equipped with an "Impulse Starter." Gift of Eisemann Magneto Corporation.

The magneto is coupled with a device which spins its armature, giving a hot spark with ordinary hand craking. The mechanism consists of an aluminum housing attached to the magneto shaft containing a spiral spring, which is compressed when the motor is turned over and automatically released.

By this operation the armature is given a sharp twist, causing a spark to be produced at the proper moment. The device does not have to be set by hand, and above 180 revolutions a minute is automatically drawn out of action. It produces the necessary rotating speed of the magneto armature to generate a spark and thereby eliminates the necessity of an auxiliary battery system, especially on engines cranked by hand, such as heavy trucks, tractors, marine engines, etc.

Cat. No. 306,998 U.S.N.M.

#### PART II.

#### APPLICATION OF POWER TO TRANSPORTATION.

#### SELF-PROPELLED ROAD VEHICLES.

One of the greatest advantages of steam power which was recognized from the earliest time of its application is that its use is not fixed as to location, as is water power or wind power, but is free to

be used where desired; that is, wherever power is required there it may be had by building a steam engine to generate it. This factor of mobility carried a step further gave to the world the first practical self-propelled vehicle when Cugnot, a French military engineer, mounted a steam engine on a three-wheeled truck and applied the power developed to propel it.

During the first half of the nineteenth century a large number of steam carriages were designed and built, particularly in England, some of them being successful and profitable. The men most prominent in this field in England were Gurney, Hancock, Dance, and Church, who built stage coaches and other public vehicles during the period from 1827 to 1834. About this time, however, laws imposing heavy highway tolls on mechanically propelled vehicles stopped further progress, and for over forty years little was done either in Europe or the United States beyond improving the type of farm tractor and steam roller. In the meantime the internal-combustion engine was being developed and improved without, however, the idea of its application to road vehicles.

As late as 1883 the oil engines produced were heavy and cumbrous, rotating at a speed of between 150 and 250 revolutions a minute. Gottlieb Daimler, however, about this time conceived the idea of a small oil engine with light moving parts, to run at a speed of 800 to 1,000 revolutions a minute. In 1886 he made his first experiment with a motor bicycle, and on March 4, 1887, ran for the first time a motor car propelled by a gasoline engine. While the motors developed by Daimler contained nothing new in their cycles of operation, great-credit must be given him for realizing the possibility of producing durable and effective engines rotating at high speeds and for providing the first step in gasoline motive power development.

The possibilities of the gasoline engine brought to light by Daimler were almost immediately taken up and developed in Europe and the United States, especially by Benz in Germany; by Panhard, Levassor, Peugeot, de Dion, Delahaye, and Renault in France; by Napier, Lanchester, Royce, and Austin in England; and by Duryea Brothers, Haynes, Apperson, Olds, Winton, and others in the United States.

Electrically driven vehicles were the latest type to be developed, and, while possessing several advantages, are as yet confined to use within a small area of travel.

Model of Sir Isaac Newton's Locomotive, 1680. Made in the Museum.

This is a small model of a machine made to prove that a reaction of a jet of steam impinging upon the atmosphere would propel a vehicle.

Cat. No. 181,282 U.S.N.M.

#### Photograph of Cugnot's Steam Traction Engine. Original in the Conservatoire des Arts et Metiers at Paris.

#### According to The Science Museum:

Nicholas Joseph Cugnot, a French military engineer, in 1769 made a steam carriage which, traveling on a common road and carrying four persons, attained a speed of two and a quarter miles an hour, but, the boiler power being insufficient, the supply of steam failed after running twelve or fifteen minutes. These results, however, induced the French Government to order the construction of an engine for the transportation of artillery which should be capable of carrying a load of about four and one-half tons and maintaining a speed of two and one-quarter miles on level ground. The machine was made in 1770 by Brezin, to Cugnot's designs, at a cost of £800, but was never tried, and is now preserved in the Conservatoire des Arts et Metiers at Paris.

It consists of a heavy timber frame supported on three wheels and carrying in front an overhanging copper boiler. The front wheel has a broad, roughened tire, and is driven by two single-acting, inverted, vertical cylinders 13 inches in diameter by 13-inch stroke. The pistons are connected by a rocking beam, and their motion is transmitted to the driving axle by pawls acting on two modified and reversible ratchet wheels. The distribution of steam to the two cylinders is performed by a four-way cock actuated by a tappet motion. A seat is provided for the driver, who, by means of gearing, was able to steer the machine, the boiler and engine turning together as a fore carriage through fifteen degrees either way.

Cat. No. 180,126 U.S.N.M.

#### Model of Murdock Locomotive, 1784. Model made in the Museum.

This locomotive was designed and constructed by William Murdock in Birmingham, England, to test the action of high-pressure steam in propelling vehicles.

The machine is three-wheeled, a steering wheel in front, and two 9½-inch driving wheels connected by a cranked axle behind. There is a rectangular boiler of copper with brazed joints which has an internal flue. A metal cup to hold alcohol is secured below the flue or fire box.

The steam cylinder is double-acting, is three-fourths of an inch in diameter, and has a 2½-inch stroke. The cylinder and valve chest are partly sunk into the boiler. A small safety valve is seated on the cylinder flange and loaded by a spring finger to retain the necessary steam pressure. A beam is carried by a post at the front end of the model and is connected at the other end with the piston rod, while a connecting rod is carried down to the crank pin of the driving axle. The steam valve is moved by the beam at each end of the stroke by a tappet action. The valve consists of two pistons connected by a tube, the space between the pistons being always open to the boiler, the exhaust from the lower end of the cylinder escaping through the connecting tube. As the valve derives its motion from the beam, the engine will continue running in either direction once it is started.

Cat. No. 181,283 U.S.N.M.

Print of Trevithick's First Road Locomotive, Camborne, England, 1801.

Woodcut, three views, from the "Memorial Edition of the Life of Richard Trevithick. E. and F. N. Spon., London, England, 1883." Presented by Trevithick's granddaughter through Colonel Davis of London.

The first load of passengers was conveyed by this locomotive on Christmas Eve, 1801. It traveled on the common roads through Camborne and climbed up a steep hill. On a subsequent trial a casting broke and the engine was left by the roadside, caught fire, and was partially burned. On March 24, 1802, a patent was granted to Rich-

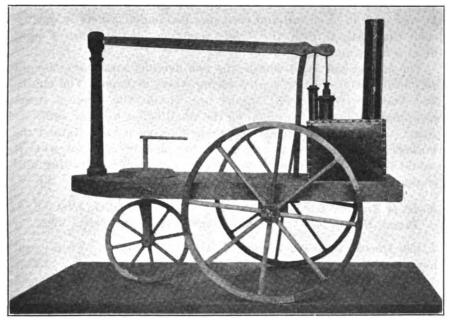


FIG. 22.-MURDOCK ROAD LOCOMOTIVE, 1784.

ard Trevithick and Andrew Vivian for steam engines for propelling carriages, etc.

Cat. No. 180,738 U.S.N.M.

Print of Drawings of Richard Trevithick and Andrew Vivian accompanying their first patent for steam engines for propelling carriages. March 24, 1802. Deposited by J. E. Watkins.

The result of the Camborne experiment of 1801 was this road locomotive with vertical double-cylinder engines, the cranks being placed at a quarter turn.

Mickleman describes it thus:

It exhibits in construction the most beautiful simplicity of parts; the most sagacious selection of appropriate forms; their most convenient and effective arrangement and connection, uniting strength with elegance, the necessary

solidity with the greatest portability; possessing unlimited power with a wonderful pliancy to accommodate to a varying resistance. It may, indeed, be called the Steam Engine.

Cat. No. 180,739 U.S.N.M.

Print of Trevithick's Second Road Locomotive, London, England, 1803. Wood cut from the "Memorial Edition of the Life of Richard Trevithick, E. and F. N. Spon, London, England, 1803." Presented by Trevithick's granddaughter through Colonel Davis of London.

This locomotive was built at Tuckingmill, in Cornwall, and differed from its predecessor in having a horizontal cylinder in place of a vertical one and at the same time being of lighter construction. It was tried in Cornwall and then sent to London, where it ran for some time daily through the streets, sometimes at the speed of eight or nine miles an hour.

The engine had three wheels, the two driving wheels about eight feet in diameter, with a small steering wheel in front. The engine and boiler were between the driving wheels, the exhaust steam escaping up the chimney enabling the small boiler to make sufficient steam. The continual trials and their subsequent cost drained the pockets of the inventor and the steam carriage was sold for what it would bring. The engine portion became a hoop-iron rolling-mill engine.

Cat. No. 180,741 U.S.N.M.

Model of Traction Engine. Patented by Cassius M. Miller, 1880. U. S. Patent, No. 227441. Transferred from United States Patent Office.

The tractor is steam driven, in which a combined vertical and horizontal boiler supported by springs from both the front and rear axles form the truck. The rear carrying wheels are driven from a countershaft supported by studs upon the rear axle and provided with a fast and loose pinion to engage with gear wheels on the traction wheels. The countershaft and axle are fixed with respect to each other to preserve the working contact of the gear wheels and pinions, but the boiler has an independent movement on the springs, which are applied to the studs. The countershaft, likewise, carries differential gearing to compensate for the unequal travel of the traction wheels when the machine turns to one side or the other. This differential gear is driven by a chain belt running over a sprocket wheel on the engine shaft and to a similar wheel from the main wheel of the differential gear.

Cat. No. 251,277 U.S.N.M.

Model of Steam Traction Engine Patented by John C. Praul, 1879. U.S. Patent No. 221354. Transferred from United States Patent Office.

The propelling forces of this tractor are two pairs of vibrating levers or walking legs. These legs are of right-angular shape and connected at their apices by links or parallel bars attached overhead to a cross shaft. The forward end of the horizontal extension of each lever is attached to the wrists of the crank shafts. These crank shafts are aligned but independent, and in place of constructing each of them in one continuous angular piece it is formed in two parts, which are rigidly connected by an interposed annulus. The wrists of these two parts are attached to the annulus at opposite points on its side and the forward end of the walking legs are also attached at the same points, the revolution of the crank shaft and its annulus imparting a complex movement to the walking legs. This movement is not unlike that of the hind legs of a cow.

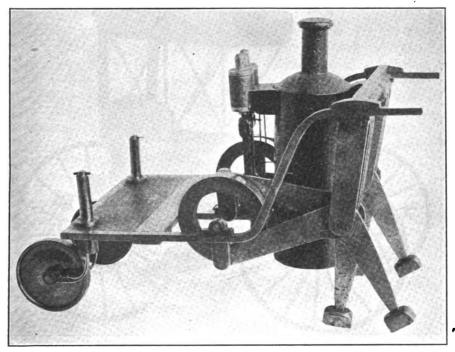


FIG. 23.-PRAUL STEAM TRACTOR, 1879.

When in operation the feet of each pair of legs will be alternately lifted from the ground and carried forward and again brought down, thus describing an approximately elliptical figure, while the legs as a whole will have a forward and backward movement, alternately rising and falling in consequence of the overhead links vibrating in the arc of a circle. The vertical extension of the legs is nearly aligned with the links overhead and the feet move in nearly a horizontal plane, so that the rear part of the body of the engine is carried smoothly or has a scarcely perceptible rising and falling movement during the time the legs are making their backward movement. A vertical boiler and the engine are carried on the rear

portion of a platform, the front of which is supported on caster wheels, which are each connected with their pivots by means of two pairs of curved plate springs.

Cat. No. 251,276 U.S.N.M.

Gasoline Automobile, 1892-1893. Gift of Inglis M. Uppercu, 1920.

This motor car was designed and constructed by Charles E. Duryea at Springfield, Massachusetts, during the year 1892-1893 and made a successful road test early in September, 1893. It is the

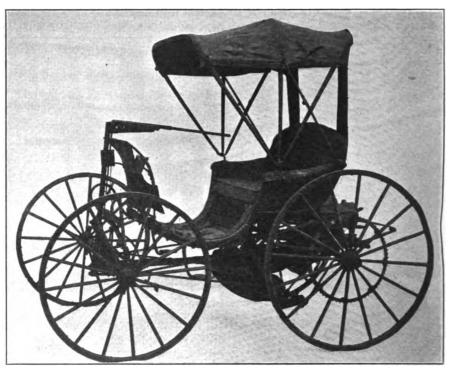


FIG. 24.—DURYEA GASOLINE AUTOMOBILE, 1892-1893.

second machine made by Duryea, the first having been completed in the autumn of 1892, which upon its trial was found to be satisfactory in design but lacking in power, and was therefore dismantled. The second machine duplicates the first in design but is equipped with a more powerful motor.

The motor is single cylinder, four cycle, water cooled, and is placed almost horizontally beneath the phaeton carriage body with its head extending backward and above the rear axle. The motor, transmission gears, and differential are swung in a frame supported at three points by rods, two at the rear axle and one at the center of the front axle. The power of the motor is transmitted through

bevel gears to a main horizontal shaft, and thence by rawhide gears to a jackshaft paralleling the main shaft, at the extremities of which is secured a sprocket wheel 1½ inches in diameter. Chains connecting these sprockets with sprockets 22 inches in diameter attached to the inner faces of the rear wheel wooden spokes deliver the power to these wheels.

On the main shaft are two friction clutches, one for forward speed and one for reverse. These clutches are operated through wire-rope connections by an up or down movement of the steering handle, the steering mechanism being of the tiller type. The steering knuckles on the front wheels are the C type, the pivot line of which intercepts the plane of the wheel at the ground.

The motor-starting crank projects at the rear and turns the crank-shaft by means of a pair of bevel gears. The motor is equipped with a spray type carbureter but without a float, gasoline being fed into the float chamber from a tank situated above the motor at a rate intended to give maximum power at the desired speed. If the motor slows down the accumulation of excess gasoline in the float chamber overflows into a tank beneath the motor, from which it is returned to the main supply tank through the medium of a hand pump. Ignition is obtained by a "make and break" electric spark, the "break" being made by a projection in the piston head.

Cat. No. 307,199 U.S.N.M.

#### Gasoline Automobile, 1893-1894. Gift of Elwood Haynes, 1910.

This motor car was designed by Elwood Haynes and built in Kokomo, Indiana, during the years 1893–1894. On July 4, 1894, a successful trial trip was made at a speed of six to seven miles an hour. The extreme dimensions of the car are, length, 7 feet 8 inches; width, 6 feet 6 inches; and height, 5 feet 2 inches.

As it now stands, the machine is not as it originally appeared, certain changes having been made about two years after the initial trial. These changes were the replacement of the one-horsepower engine by a two horsepower; the replacement of the 28-inch cushion-tire wheels with 36-inch pneumatic-tire wheels; and the substitution of a tiller type of steering mechanism for the original worm type attached to the center of the axle. To make this change, the axle was made rigid by the braces of a single piece of rectangular steel extending from the ends of the axle through the swiveled head and attached thereto. Bell cranks were then attached to the front wheel spindles and the latter arranged to swivel in forks attached to the ends of the axle.

The vertical water-cooled motor delivers its power by double chain and sprockets to a jackshaft forward, thence to the rear wheels by a second set of chains and sprockets. Friction clutches on the jackshaft

are operated by a vertical T rod within reach of the driver. On the lower end of this rod is a sprocket wheel and chain at the ends of which are attached wire ropes running over pulleys and attached to the clutches. Braking is obtained by a friction band on the jackshaft, operated by a hand lever.

The water tank is beneath the carriage seat, while the radiator and gasoline tank are beneath the floor toward the front. The carbureter feed is controlled by a foot pedal. The motor is cranked through the spokes of the right rear wheel. The chassis is a rectangular tubular

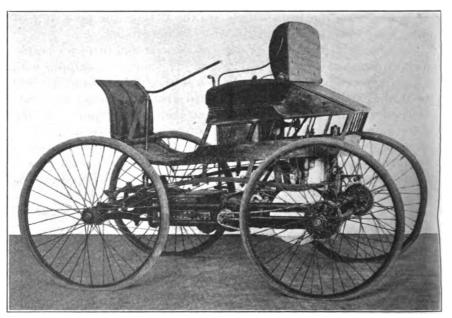


FIG. 25.—HAYNES GASOLINE AUTOMOBILE, 1893-1894.

frame upon which rests the auto body on semielliptical springs. Its total weight without passengers is 1,020 pounds.

Cat. No. 262,135 U.S.N.M.

#### Gasoline Automobile, 1894. Gift of Stephen M. Balzer, 1899.

This car was designed and built by Mr. Balzer in New York City in 1894. It is equipped with a three-cylinder air-cooled rotary motor whose power is transmitted through a chain of gears to a gear on the revolving shaft on which the rear wheels are mounted.

The rear wheels are 28 inches in diameter and the front wheels are 18 inches in diameter, equipped with pneumatic tires, and swung in forks of the bicycle type.

Cat. No. 181,658 U.S.N.M.

#### Gasoline Automobile, 1896. Gift of the Olds Motor Works.

This machine was constructed by R. E. Olds in Lansing, Michigan, and was first successfully operated in 1896 at a speed of eight to ten miles an hour, carrying four passengers.

The car is equipped with a six horsepower single cylinder watercooled motor placed horizontally beneath the rear portion of the carriage body, and with the crank shaft about midway between the



FIG. 26.-OLDS GASOLINE AUTOMOBILE, 1896.

front and rear axles. Power is transmitted through sprockets and chains to the rear driving wheels. The wheels are of wood equipped with solid rubber tires. Mounted on an extension of the crank shaft are friction clutches controlled by a vertically revolving post near the driver. The steering mechanism is of the tiller type, the right and left motions being transmitted to the wheel spindles through a radius rod.

The whole power plant is swung centrally beneath the body, the crank-shaft end of the motor being supported by curved iron straps attached to the front axle, and the cylinder head hanging from the rear portion of the body over the axle. A cellular water-cooling

radiator is attached to the under side of the carriage body above the motor. The water tank is located below the rear seat of the carriage, while the gasoline tank is placed parallel to the motor, but beneath it.

Cat. No. 286,567 U.S.N.M.

## Gasoline Automobile, 1901. Gift of The Autocar Company.

This motor car was designed and constructed by Louis S. Clarke, vice president and consulting engineer of The Autocar Co., in Ardmore, Pa., between September, 1901, and December of that year, and is believed to be the earliest motor vehicle equipped with shaft drive. It was first exhibited at the automobile show held in Madison Square Garden, New York City, December 11, 1901, having been driven

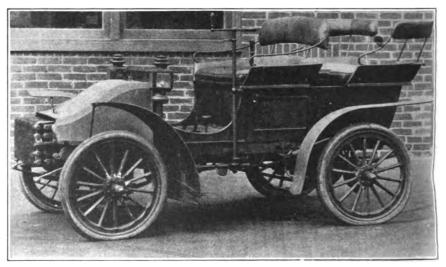


FIG. 27.—SHAFT DRIVEN AUTOCAR, 1901.

there under its own power from Ardmore, Pa., a distance of over 90 miles, in 6 hours and 15 minutes. The car was run by Mr. Clarke, exactly as built and as it now is, for over three years and covered a total of at least 5,000 miles.

The gasoline engine is of the opposed type, having two water-cooled cylinders each of 3½ inches bore and 4-inch stroke, and equipped with automatic inlet valves. The transmission is of the selective type, having two forward speeds and reverse. The power is delivered to the rear wheels through a shaft coupled by two universal joints. Lubrication is effected from a dashboard sight-feed oiler. The frame is made of wood and reinforcing steel and is supported on the axles by four full elliptical springs. This car has a seating capacity for four persons, the two tonneau seats being entered from the rear. The wheel base is 66½ inches and the tread 56 inches.

Cat. No. 307,257 U.S.N.M.

#### BAILWAY LOCOMOTIVES.

The first practical locomotive engine designed to run upon rails was built in 1804 by Richard Trevithick, a Cornish mine captain, in southern Wales. In the same year Oliver Evans, of Philadelphia, Pennsylvania, built a steam dredging scow weighing about 4,000 pounds. To convey it from his shop to the river, he mounted the scow upon wheels and propelled it by the steam engine. This was the first self-propelled vehicle to run on American soil.

While Trevithick's locomotive in itself was successful, the castiron railway-the rail was an extended angle iron, having a 3-inch face upon which the wheels ran, the vertical face acting as a guide and being on the inside—proved faulty and broke continually, so that from an economic point of view the locomotive was more expensive than the horse. To devise a locomotive whose weight would have sufficient adhesion and still be light enough to prevent the breaking of rails engaged the attention of inventors for the next twenty years in England. Thus John Blenkinsop in 1811 patented a rack railway and locomotive and William Hedley in 1813 built a locomotive named "Puffing Billy" which had smooth wheels coupled together by gearing. It was the beginning of the grasshopper type of engine which became the fashion until 1829. George Stephenson in 1814 constructed his first locomotive, which was not a success, but in his second he used the direct action of the connecting rods on the driving wheels, and at first used coupling rods for connecting the wheels, but later discarded them for chain gearing, with the result that a successful type of locomotive was obtained and one superior to horse traction.

The results obtained by Stephenson's locomotive "Rocket." built in 1829 for the Liverpool and Manchester Railway, settled definitely the relative merits of the steam locomotive and the horse-drawn vehicle in favor of the former, and laid the foundation for the successful future of railway transportation.

In the United States railway developments paralleled those of England. The South Carolina Railroad Co. was the first in the world to decide that its railroad should be operated by steam locomotives. Its construction was begun in 1827, but delays prevented its opening until after a portion of the Baltimore & Ohio Railroad was in operation. The first locomotive on the American continent designed to run on rails was bought in England and brought to this country for the Delaware & Hudson Canal Co., while the first American-built locomotive for actual service was designed by a merchant of Charleston, South Carolina, was built by the West Point Foundry, New York City, and tried out on the South Carolina Railroad in 1831. As early as 1812 John Stevens, of Hoboken, urged the

building of railways operated by steam locomotives rather than the building of canals. In an endeavor to have a more convincing argument as to the feasibility of the steam locomotive, Stevens built a locomotive in 1825 and operated it on a circular track in Hoboken.

The whole country realized the necessity for means of transportation of commodities but the people were divided in their opinions as to the form it should take—canals or railroads. Governor De Witt Clinton, of New York, urged the building of canals, more particularly the Erie Canal; John Stevens, Peter Cooper, and others advised the building of railways. In 1829 Peter Cooper constructed a model locomotive and ran it over the completed portion of the Baltimore & Ohio Railroad. The result was that the company offered a premium of \$4,000 for a locomotive, built in the United States, which would draw 15 tons gross weight at 15 miles an hour. This offer in time brought five locomotives to the company, all built at different places, all different in design, and in no way resembling the British models. The first was made by George W. Johnson, a machinist of Baltimore, Maryland. The second was the "York." designed by Phineas Davis and built by Davis and Gartner, of York, Pennsylvania. It consisted of upright cylinders attached to the vertical boiler and transmitted power to the four driving wheels through connections with the side rods. The third was built in Philadelphia, Pennsylvania, by a watchmaker named Stacev Costell. Ezekial Childs, another watchmaker of Philadelphia, supplied the fourth, and the fifth was built by William T. James, of New York.

From 1820 on, sentiment in favor of railroad building developed very rapidly and the men who took the lead in advocating railroads were the most influential in the country and had clear conceptions of what they wanted. The Camden & Amboy Railroad and Transportation Co. was incorporated in February, 1830, and was authorized to construct a railroad from the Delaware River to Raritan Bay, that is, across the State of New Jersey. Its first locomotive was the "John Bull," purchased in England of Robert Stephenson & Company, and received in Philadelphia in 1831. The Mohawk & Hudson Railroad Co., chartered in 1826, began the construction of its railroad between Albany, New York, and Schenectady, New York, in 1830, which was completed and opened in August, 1831, the first train being drawn by the locomotive "De Witt Clinton," designed by John B. Jervis and built at the West Point Foundry, New York City.

Matthias W. Baldwin upon request built a model locomotive and train for the Philadelphia Museum in 1831. Shortly after its completion Baldwin was engaged to build a locomotive for the newly incorporated Philadelphia, Germantown & Norristown Railroad Co. He took as a working model the locomotive "John Bull," and from



THE "JOHN BULL" LOCOMOTIVE. THE OLDEST COMPLETE LOCOMOTIVE IN AMERICA.

it built "Old Ironsides," which was tried out late in 1832. His second locomotive was the "E. L. Miller," completed in 1834, which had very little that was decidedly original, but old forms were combined in a shape that produced the best locomotive then built, and the American locomotive of to-day is undoubtedly a direct development of the "E. L. Miller." Its particular features were a horizontal boiler with Bury's haystack fire box, one pair of driving wheels located behind the fire box, the Jervis four-wheel swiveling truck under the smoke box, and outside wooden frames sheathed with

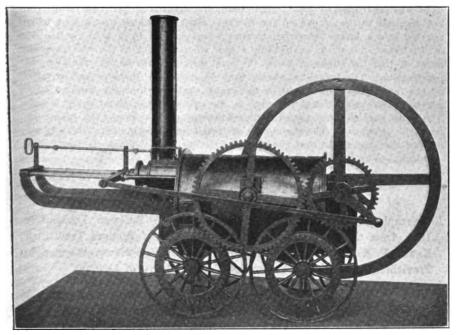


FIG. 28.—TREVITHICK LOCOMOTIVE, 1804.

iron. The cylinders, 10 by 16 inches, were secured between the smoke box and frames and transmitted power to the driving wheels through a half-crank axle. The engine weighed in working order about 16,600 pounds.

## Model of Trevithick Locomotive, 1804. Made in the Museum.

While building some of his high-pressure steam engines at the Pen-Y-Darran Iron Works near Merthyr, Tydvil, in 1803, Trevithick undertook to construct a steam locomotive to haul trucks on a tramway a distance of about 9 miles. The engine was completed early in 1804, and upon its trial drew five wagons with a load of 13 tons at a speed of about 5 miles an hour, with a coal consumption

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of about 25 pounds a mile. It also drew empty wagons up an incline of one in eighteen at the rate of 4 miles an hour. Owing to the frequent breakages of the cast-iron tram parts, however, the locomotive was abandoned as such and used for stationary purposes. The model, therefore, represents the first steam engine that ran on a track by the force of high-pressure steam, relying wholly upon the adhesion of smooth wheels.

The locomotive had a single horizontal cylinder 8½ inches in diameter by 54 inches stroke, inclosed in the boiler, which was of cast iron, 6 feet long and 4½ inches in diameter, with a wrought-iron furnace flue. The piston-rod crosshead was controlled by round guide bars, and from it passed two return connecting rods to the cranks on the flywheel shaft, on which was a spur wheel gearing into a larger intermediate spur wheel carried by a stud on the side of the boiler; this wheel geared into a spur wheel on each of the two travelling axles, so that the adhesion due to the total weight of the engine was available for traction. The traveling wheels were 45 inches in diameter and rovolved at practically the same speed as the crank shaft, so that the tractive effort per pound of mean steam pressure in the cylinder was about forty pounds. The valve arrangement consisted of a four-way cock worked by a tappet rod from the crosshead. The steam was delivered into the chimney, where it was noticed that the waste heat rendered it invisible, and it made the draft much stronger. (The Science Museum.)

The total weight of the engine in working order was five tons.

Cat. No. 180,058 U.S.N.M.

Lithograph of Trevithick's Newcastle-upon-Tyne Railway Locomotive, 1805, from the "Memorial Edition of the Life of Richard Trevithick, E. and F. N. Spon, London, England, 1883." Five views presented by

Trevithick's granddaughter through Colonel Davis, of London.

This locomotive was built in Newcastle about the end of 1804. It differed from its predecessor (the South Wales locomotive) in being fitted to run on a railway by using flanged wheels.

Cat. No. 180,740 U.S.N.M.

Print of Trevithick's London Circular Railway and "Catch-me-who-can" Locomotive, 1808. Woodcut from the "Memorial Edition of the Life of Richard Trevithick, E. and F. N. Spon, London, England, 1883." Presented by Trevithick's granddaughter through Colonel Davis, of London.

Between the close of 1800 and May, 1805, Trevithick had constructed two road locomotives in Cornwall, a tramway locomotive in Wales, and one railway locomotive in Newcastle. All these had some form of blast pipe. For the next three years Trevithick did nothing with the locomotive, but in 1808 he constructed, at his own cost, a locomotive and a circular railway on the southern half of the present Euston Square, London. The engine working on this railway was called "Catch-me-who-can." It weighed 10 tons and

attained a speed of 12 miles an hour. It ran for some weeks, when a rail broke and it left the road and turned over. Trevithick, having expended all his means to convince the public of the utility of the locomotive, was compelled to give up his endeavors. There is no record to show that Trevithick ever resumed his labors in this branch of engineering.

Cat. Nos. 180,734-735 U.S.N.M.

# Photograph of "Locomotion," Engine No. 1, (1825) of the Stockton and Darlington Railway, England.

This is the first locomotive built for the first railway in the world and constructed for general traffic. The photograph was made at the Chicago Exposition of Railway Appliances in 1883, when the focomotive was exhibited by the Stockton and Darlington Railway.

The engine has two vertical cylinders, 10 inches in diameter by 24 inches stroke, each driving by side-connecting rods a pair of 48-inch driving wheels. These wheels are of cast iron and are coupled together by external rods that elevate the driving crank pins of the ordinary type driven by rocking shafts, which both receive their motion from a single eccentric on the leading axle, one shaft being rocked directly and the other through a "bell-crank" lever. A platform runs along each side of the boiler, and from one of these the engineer has control of the valve rods for disengaging and reversing. The tractive power for this engine per pound of mean pressure in the cylinders was 50 pounds, but the boiler pressure used was only 25 pounds per square inch. The exhaust steam from both cylinders was conveyed by two waste pipes to the chimney. The feed water was forced into the boiler by a single feed pump, 4 inches in diameter, driven by a lever from the crosshead. The boiler is 10 feet long and 4 feet in diameter, delivering into the chimney, which is 17½ inches in diameter.

The wheel base of the engine is 5 feet 4 inches, and the weight in working order is 6½ tons. The tender is built of timber and holds fifteen hundredweight of coal and carries an iron tank containing 240 gallons of water. (The Soience Museum.)

This locomotive is estimated to have been about 20 horsepower and to have a speed of about 8 miles an hour.

Cat. No. 180,760 U.S.N.M.

# Model of the "Bocket" Locomotive and Tender, 1829. Made in the Museum.

This model represents the celebrated engine constructed by R. Stephenson & Co. in 1829 to compete for the prize of £500 offered by the Liverpool and Manchester Railway in England to the makers of the most successful locomotive.

The competition commenced on October 6 and continued for eight days. "The Rocket" won the competition against four other entries. These were "The Novelty," made by Messrs. J. Braithwaite and J. Ericsson; "The Sans Pareil," made by Timothy Hackworth; "The

Perseverance," made by T. Burstall; and the "Cyclopede," made by T. S. Brandreth. Trials were conducted at Rainhill, near Liverpool, on a level piece of the line 13 miles in length, of which 220 yards at each end were allowed for starting and stopping. The competing engines were required to make ten double trips, going over the central 11 miles at full speed, which was to represent a journey from Manchester to Liverpool. Then a fresh supply of water and fuel could be taken up and the second ten trips performed, which represented the return journey. The average speed throughout had to be no less than 10 miles an hour. "The Rocket" was the only en-

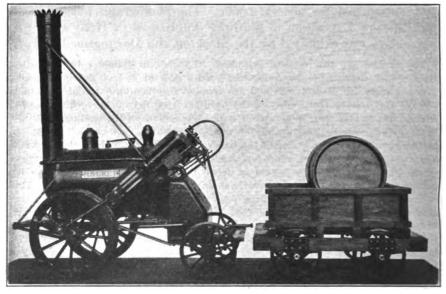


FIG. 29.—STEPHENSON " ROCKET," 1829.

gine to complete the journeys and fulfill all the conditions, and was, therefore, awarded the prize. She weighed 41 tons and drew a load of 123 tons. She completed the whole of the double journey at an average speed over the central portion of the track of 13.8 miles an hour, her maximum speed for one trip being 24.1 miles an hour.

The engine ran on four wheels and had two cylinders 8 inches in diameter by 17 inches stroke placed at the rear end of the boiler and inclined downward at 37 degrees with the horizontal; the piston rods drove the front wheels, which were 56.6 inches in diameter, thus giving a tractive factor of 19.4. The trailing wheels were 34 inches in diameter and the wheel base 7.17 feet. The cylinders were mounted on iron plates which were bolted to the boiler shell and supported by stays; these plates also carried the guide bars, which were of square section set diagonally, while the crossheads were of brass, in halves, bolted together and embracing the bars. The steam chests were below the cylinders and the slide valves were driven through an intermediate shaft and levers by

a pair of eccentrics fixed to a loose sleeve which could be moved endwise along the shaft by a pedal so as to engage with either of two drivers, one set for forward and the other for backward running. The valve rods had gab ends, so that the valves could be disengaged and worked by hand levers when reversing. The crank pins had spherical ends to allow for irregular motion of the engine relative to the driving axle.

The boiler was a cylindrical shell 40 inches in diameter by 6 feet long, made in two rings, with a circumferential lap joint and longitudinal butt joints, the flat ends being secured by angle rings and tied together by longitudinal stays. The shell was traversed by 25 copper tubes 3 inches in diameter secured in holes through the end plates. The fire box shown is of the original design, but it is not certain how soon it was altered in shape. It was a separate chamber of copper bolted on to the back end of the barrel. It was rectangular in plan, with a sloping back, in which was the fire box. There were water spaces at the top, back, and sides, while there was a fire-brick lining in front below the tubes. Copper pipes connected the water and steam spaces of the fire box with those of the barrel. The total heating surface of the boiler was 138 square feet, that of the fire box being 20 square feet, and the grate area was 6 square feet. The chimney was nearly 15 feet high above the rails and was swelled out at the base to cover the tube ends, and was supported by stays from the cylinder plates.

Steam from the boiler was admitted to the cylinders by two pipes leading from a regulating cock fixed above the fire box, and which received steam from a dome through an internal pipe. The boiler pressure was limited to 50 pounds per square inch by two safety valves, one of which was loaded by a spring and lever, while the other was a lock-up valve covered by a small dome. A mercurial gauge was fitted beside the chimney and was arranged to indicate the steam pressure from 45 to 60 pounds. A water gauge was fitted behind one of the cylinders and two gauge cocks near the front end of the boiler. The feed water was introduced by a long stroke feed pump worked from one crosshead, while the exhaust steam was passed into the chimney by two pipes, each fitted with a brass nozzle 1.5 inches in diameter.

The framing of the engine was wholly between the wheels and was built of flat bar iron bent down at the rear end to accommodate the fire box and rear axle; to this the cast-iron guides were secured, and four brackets to support the boiler. The weight was transmitted to the axles by plate springs. The driving wheels were constructed with cast-iron bosses in which the crank pins were fixed, oaken spokes and fellies, and iron tires secured by bolts. The engine weighed 3.25 tons when empty and 4.25 tons in working order.

The tender was a four-wheeled wooden truck carrying the fuel in the body and the water in a large barrel above it. The axles had outside bearings and plate springs, the wheels were 36 inches in diameter and the wheel base was 4 feet. It weighed 3.2 tons when loaded, so that the total weight of engine and tender in working order was 7.45 tons.

Cat. No. 180,243 U.S.N.M.

# Model of John Stevens Experimental Locomotive, 1825. Made in the Museum.

The locomotive consists of a four-wheel platform truck upon which is mounted a vertical tubular boiler inclosed in a circular sheet-iron casing terminating in a conical hood that holds the furnace door, and upon the hood rests the smoke-stack. The furnace and its grate are circular and are placed inside of the circle formed by the boiler tubes and thus are inclosed by them. The grate rests on the projecting ledge of the lower part of the boiler. A single horizontal cylinder with valve chest on top is situated alongside the boiler and transmits its power to a crank shaft on which is mounted a gear wheel. This gear engages a second and larger gear vertically beneath it, which in turn meshes into a rack rail situated midway between the rails and about on a level with them. Four vertical posts extending downward from the floor of the truck near each

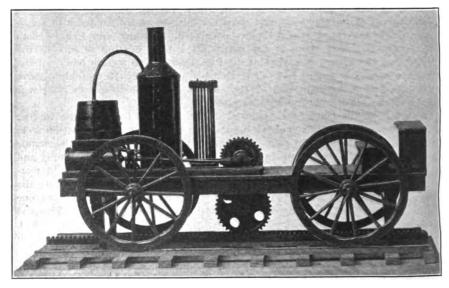


FIG. 30.-STEVENS' EXPERIMENTAL LOCOMOTIVE, 1825.

corner and terminating in rollers in contact with the inner face of the rails, guide the truck on the track.

The locomotive was operated by Stevens on a circular track at Hoboken, New Jersey, and carried six people at a speed of over twelve miles an hour.

Cat. No. 181,241 U.S.N.M.

Original Tubular Boiler Designed and Patented by John Stevens in 1803, and Used on His Experimental Locomotive in 1825. Deposited by the Stevens Institute of Technology.

The boiler consists of twenty vertical tubes connecting the water chamber at the bottom with the steam chamber at the top. The outside diameter of the circle formed by the tubes is 12 inches, each tube being 403 inches long by 13 inches in external diameter.

The steam and water chambers are annular spaces of about 1 square inch cross section and 10½ inches in diameter, containing each about 33 cubic inches.

The cap of the steam chamber is secured by ten large and five small bolts, the diameters of which are eleven-sixteenths and five-eighths of an inch, respectively. The steam outlet at the top is a pipe 1 inch in diameter, the water inlet being a similar aperture at the bottom.

Cat. No. 180,029 U.S.N.M.

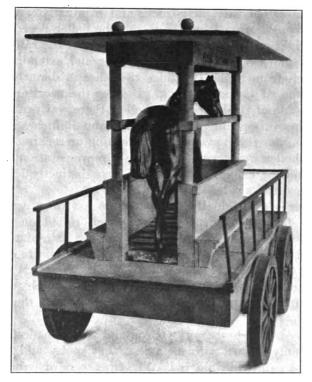


FIG. 31.-HORSEPOWER LOCOMOTIVE, "THE FLYING DUTCHMAN," 1830.

# Model of "The Flying Dutchman," Horsepower Treadmill Car. Made in the Museum.

In 1829 the South Carolina Railroad Company offered a premium of \$500 for the best locomotive operated by horsepower. This premium was awarded to Mr. C. E. Detmold, who invented one which was worked on an endless-chain platform or treadmill.

When this horsepower locomotive was completed and tested upon the road in 1830 it carried 12 passengers at the rate of 12 miles an hour. It was propelled by one horse walking on the treadmill, which was connected by gearing to the carwheel axles.

Cat. No. 181,086 U.S.N.M.

Parts of the Locomotive "Stourbridge Lion" Consisting of boiler, wheels, walking beams, and one cylinder. The first locomotive on the Western Hemisphere to run on a railroad built for traffic. Gift of the Delaware and Hudson Canal Co.

The locomotive, "Stourbridge Lion," is a four-wheeled engine, all of whose wheels are "driving wheels" and 4 feet in diameter. The boiler is cylindrical and horizontal, 104 feet long including the swell of the end plates, and 4 feet 2 inches in diameter. It is constructed of iron plates, one-half inch thick, and originally a chimney 18 inches in diameter rose from the top of the boiler near its forward end to a height of about 15 feet from the top of the rails. The fire box was cylindrical, 28 inches in diameter and extending into the boiler 4 feet, from which two flues 18 inches in diameter extended to the bottom of the smokestack. Besides the necessary openings for the passage of steam from the boiler, there was near the center of its top an oval opening 12 inches wide and 16 inches long, called a "manhole," for the convenience of cleaning or repairs. The front end of the boiler was ornamented with a representation of the face of a lion and the name "Stourbridge" was distinctly lettered on a plate attached to its side.

The boiler was originally supported on a strong, wrought-iron frame, the front two-thirds part of which rested on two, many plated heavy steel springs which rested on the axle of the forward wheels, and the rear one-third part rested on supports on the axle of the rear wheels.

Under the center of the boiler and supported by this iron frame was a small water tank from which water to supply the boiler was pumped.

The hubs of the wheels were of iron and were "made fast" to the axles so as only to turn with the axles. The spokes and fellies were of wood and painted bright red. The tires were of wrought iron 4 inches wide and ½ inch thick, formed of two plates each three-fourths of an inch thick and fitted one around the other. They were 4 feet in diameter, exclusive of the flanges, which projected three-fourths of an inch beyond the face of the tires.

A cylinder was placed upright on each side of the rear end of the boiler arranged for a stroke of 36 inches. The upper end of each piston rod was connected to one end of a lever 6 feet in length called a "walking beam," in form resembling the walking beam of a steamboat, the other end of which rested on fulcrums on the top of two movable or vibrative upright iron rods, connected together by cross braces, the bottom of the fulcrum rods working on hinge joints and the top being of such height that when the piston was at half stroke the beam would be level.

Attached to the head of each cylinder was an iron frame consisting of two upright posts so placed that the piston end of the beam would pass between them and permit the end of the beam to pass clear of it. The height of these frames was on a level with the head of the piston rod when at half stroke. These frames were firmly braced so as to hold them perfectly in place.

In the center of each walking beam a journal projected on each side to which two radius rods were attached, the other end of such rods being attached by journals to the head of the posts of the upright iron frames in such positions that their journals would be exactly in line with the piston-rod journal when the piston was at half stroke. By this arrangement the head of the piston rod was at all times kept in line with the center line of the cylinder.

The valves regulating the passage of steam into and out of the cylinders were operated by rods and cranks connected with eccentrics on the rear axles, the angle of the eccentrics being such that when one piston was at full stroke the other would be at half stroke.

The journals for connecting the crank rods with the walking beams were placed at a distance of 18 inches (one-fourth the length of the beam) from the piston-rod journal, thus making the diameter of the crank sweep equal to three-fourths of the stroke of the piston. Crank rods extended from these journals to the crank pins in the rear wheels and these, by horizontal connecting rods, were made to turn the forward wheels.

The exhausted steam was discharged from the cylinders into two pipes 2½ inches in diameter, one being attached to each cylinder and extending downward into the small water holder under the boiler, thus utilizing the heat of such exhausted steam in partially heating the water for supplying the boiler. From this small water holder one pipe extended forward under the boiler and upward across its front end, where it discharged into the chimney.

The engine was provided with two safety valves, one of which was placed back of the center of the boiler where the engineer could have ready access to it and the other was placed very near to and in the rear of the chimney and was so covered by a dome as not to be easily accessible. The reason for such arrangement may be inferred from one of the conditions contained in the offer by the Liverpool and Manchester Railway managers in 1829 of a £500 prize for the best locomotive for passenger trains, namely, "The boiler must have two safety valves, neither of which must be fastened down, and one of them completely out of control of the engineer."

The "Stourbridge Lion" was built by Foster, Rastrick & Co., in Stourbridge, England, a manufacturing town on the River Stour, about 15 miles west of Birmingham. It was manufactured especially for the Delaware & Hudson Canal Co. by order of Mr. John B.

Jervis, president of the company, who commissioned Horatio Allen, a prominent practical engineer, to arrange the details for this work.

In February, 1829, the "Stourbridge Lion" was sent by canal to Liverpool and consigned to William and James Brown, who were bankers for the Delaware & Hudson Canal Co., and on April 8, 1829, it was shipped from Liverpool on the John Jay for New York. The boat arrived in New York on May 14, and the parts of the locomotive were taken to the yard of the West Point Foundry Co., of which W. Kimball was the manager. This foundry was at the foot

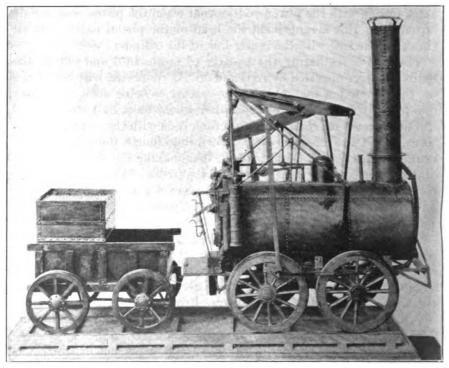


FIG. 32.—REPRODUCTION OF THE OBIGINAL "STOURBRIDGE LION" LOCOMOTIVE.

of Beach Street, North River, New York City. The locomotive was put together by David Matthew under the supervision of Horatio Allen, and was blocked up with wheels clear of the ground and run as an interesting exhibition to people who called to see it. It was later shipped up the Hudson River to Rondout, New York, and forwarded thence by the Delaware & Hudson Canal to Honesdale, Pennsylvania, arriving at that place on July 23. It was there elevated from the canal to the railroad track, which is said to have run on a trestle some distance from the canal. On August 8, 1829, the trial trip was made, and the locomotive, manned by Horatio Allen alone, ran out on the track a distance of about 1 mile to Seeleyville.

Horatio Allen's account of this trip is quite circumstantial, but does not agree with other statements which seem to be reliable. Mr. Allen says that he ran the locomotive 2 or 3 miles, while other statements are that the trip was not more than 1 mile long. It seems likely that, in addition to this first trial trip, a few other experimental trips were made and then the locomotive was laid aside.

Cat. No. 180,013 U.S.N.M.

#### Model of Locomotive "Stourbridge Lion." Made in the Museum.

There are quite apparent differences between this model and the partially assembled original locomotive on exhibition. As con-

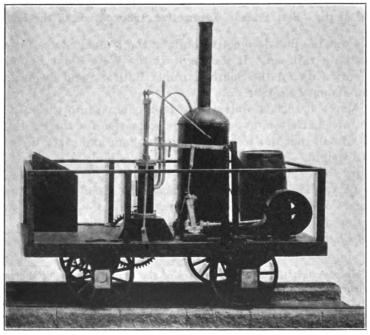


FIG. 33.-PETER COOPER EXPERIMENTAL LOCOMOTIVE, 1829.

structed, the model is a composite picture developed from numerous bits of what is believed to be reliable information gathered over a long period of years, and is considered to be a true likeness of the original as received from England.

Cat. No. 215,649 U.S.N.M.

# Model of the Experimental Locomotive "Tom Thumb," 1829. Made in the Museum.

This engine was designed and constructed by Peter Cooper in Baltimore, Maryland, and tested on the Baltimore & Ohio Railroad on August 28, 1829. On that occasion it drew a car carrying 24 pas-

sengers a distance of 13 miles in 72 minutes, and made the return trip in 57 minutes.

The engine was about the size of a modern hand car with one upright cylinder \(\frac{3}{4}\) inches and an upright boiler, the tubes of which were made from gun barrels. The boiler was about as large as a kitchen boiler; stood upright in the car, and was filled above the furnace, which occupied the lower section, with vertical tubes. Draft for the fire was maintained by a revolving fan driven by a drum attached to one of the car wheels over which passed a cord that in its turn worked a pulley on the shaft of the revolving fan. The rotating action of the engine was transmitted to the wheels through a system of gears.

Cat. No. 180,034 U.S.N.M.

Model of the "Best Friend" Locomotive, 1830. Made in the Museum.

This was the first locomotive built in the United States for actual service on a railroad. It was built at the West Point Foundry in New York City for the South Carolina Railroad and made its trial trip on January 15, 1831.

On March 1, 1830, a contract had been entered into with Mr. E. L. Miller, of Charleston, to construct a locomotive for the South Carolina Railroad that was to run 10 miles an hour and carry three times its own weight. Mr. Miller's locomotive was built at the West Point Foundry shops, at that time located at the foot of Beach Street, New York City. The "Best Friend" gave such good service that the managers of the road directed that a second locomotive be ordered from the same company with changes and modifications.

The Charleston Courier of January 17, 1831, described the initial trip as follows:

On Saturday last the first anniversary of the commencement of the railroad was celebrated. Notice having been previously given, inviting the stockholders, about one hundred and fifty assembled in the course of the morning at the company's building in Line Street, together with a number of invited guests. The weather the day and night previous had been stormy, and the morning was cold and cloudy. Anticipating a postponement of the ceremonies, the locomotive engine "Best Friend of Charleston" had been taken to pieces for cleaning, but upon the assembling of the company she was put in order, the cylinders new packed, and at the word the apparatus ready for movement. The first trip was performed with two pleasure cars attached, and a small carriage, fitted for the occasion, upon which was a detachment of United States troops and a fieldpiece which had been politely granted by Maj. Belton for the occasion.

Upon the return of the engine it was found necessary to tighten the packing, which occasioned some little delay. At about 1 o'clock she again started with three cars attached, upon which were upward of 100 passengers. At 2 o'clock a Federal salute was fired by the detachment of troops stationed upon the remains of the fortification erected during the Revolution near the Quarter House. At 4 o'clock the company commenced returning and were all safely landed at Line

Street before 6. The number of passengers brought down, which was performed in two trips, was estimated at upward of 200. A band of music enlivened the scene, and great hilarity and good humor prevailed throughout the day.

Mr. David Mathew, who was foreman of machinists in the West Point Foundry, Beach Street, New York City, when the "Best Friend" locomotive was built, writes the following particulars of the engine in a letter written in 1859 to William H. Brown, author of the "First Locomotive in America":

The "Best Friend" locomotive was a four-wheeled engine, all four-wheels drivers. Two inclined cylinders at an angle, working down on a double crank

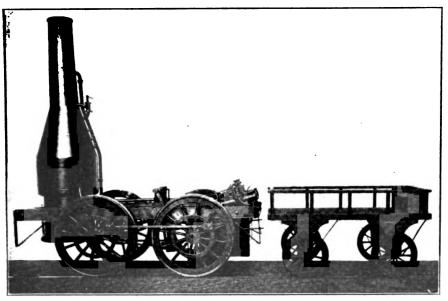


FIG. 34.-THE "BEST FRIEND" LOCOMOTIVE, 1831.

inside of the frame, with the wheels outside of the frame, each wheel connecting together with outside rods. The wheels had iron hubs, wooden spokes, and fellies with iron tires and iron web and pins in the wheels to connect the outside rods to.

The boiler was a vertical one in the form of an old-fashioned porter bottle. The furnace at the bottom was surrounded with water and all filled inside full of what we call teats running out from the sides and top, with alternate stays to support the crown of the furnace; the smoke and gas passed out through the sides at several points into an old jacket which had the chimney on it. The boiler sat on a frame upon four wheels, with the connecting rods running by it to come into the crank shaft. The cylinders were about 6 inches bore and 16 inches stroke and the driving wheels about 4½ feet in diameter. The whole machine weighed about 4½ tons.

Figured by present rules the traction force with 50 pounds boiler pressure was about 400 pounds. Also, at a speed of 20 miles an

hour and a working steam at three-quarters stroke the engine would develop about 12 horsepower. Rich pine wood was the fuel used. Upon trial it was found that the wheels were too weak for lateral strains exerted upon them in rounding curves, and they had to be rebuilt with wrought-iron spokes.

The engine proved highly efficient and doubled the power and speed stipulated in the contract.

Cat. No. 180,244 U.S.N.M.

Copy of the Original Drawing of the "West Point," the Second Locomotive Engine Built for Actual Service on a Railroad in the United States.

This locomotive was made for the South Carolina Railroad in 1830 by the West Point Foundry Association. It had the same size engine, frame, wheels, and cranks as the "Best Friend," but had a horizontal tubular boiler. The tubes were 2½ inches in diameter and about 6 feet long.

The public demonstration of this locomotive's power was made on March 5, 1831, on Sunday afternoon. The Charleston Courier of March 12th describes this trip as follows:

The locomotive "West Point," under the charge of Stephen Lee Alison, underwent a trial of speed with the barrier car and four cars for passengers on our railroad. There were 117 passengers, of which number 50 were ladies, in the four cars, with 6 bales of cotton on the barrier car; and the trip to the Five-Mile House, 2½ miles, was completed in eleven minutes. The 2½ miles to the forks of Dorchester Road were completed in eight minutes. The safety has been insured by the introduction of the barrier car and the improvements of the formation of the flange of the wheels, which, we learn, was made by a young mechanic of the city, Mr. Julius D. Petsch, in the company's service.

The barrier car referred to was a car surmounted with six square bales of cotton strapped upon it by means of hoop iron, and was run with every passenger train, being placed between the locomotive and passenger cars as a means of protection from steam or hot water should an accident occur.

Cat. No. 180, 711 U.S.N.M.

The Locomotive "John Bull," 1831. No. 1, Camden and Amboy Railroad Company. The Oldest Complete Locomotive in America. Built by George Stephenson and Son, Newcastle-upon-Tyne, England, 1830-31; Shipped from Liverpool July 14, 1831, on the Ship "Allegheny" Bound for Philadelphia. Gift of the Pennsylvania Railroad Company, 1885. Plate 2.

On November 12, 1831, in the presence of members of the New Jersey Legislature, with Isaac Dripps acting as engineer, in a train with two cars, this locomotive made the first movement by steam in the State of New Jersey, at Bordentown, where the Railroad Monument now stands. The "John Bull" was in continuous service from 1831 to 1865, during which time it was altered and added to. It was ex-

hibited at the Centennial Exhibition, 1876, and at the Exposition of Railroad Appliances, Chicago, 1883. It was placed in the United States National Museum in 1885, where it remained until 1893, when (April 17–22) it was run under steam from New York to the World's Columbian Exposition, where for a time it made daily trips upon the exposition tracks. On December 13, 1893, it was returned to Washington, D. C., having made the last trip under steam on that date.

The original dimensions were as follows: Weight, 10 tons (22425 pounds). Boiler, 13 feet long, 3 feet 6 inches in diameter. Cylinders, 9 by 20 inches. Driving wheels, 4 feet 6 inches in diameter; cast-iron hubs; locust spokes; tire of wrought iron, shrunk on; flange, 1½ inches deep. Sixty-two flues, 7 feet 6 inches long, 2 inches in diameter. Furnace, 3 feet 7 inches by 3 feet 2 inches high. Steam ports, 1½ by 6½ inches; exhaust ports, 1½ by 6½ inches. Throw of eccentric, 3½ inches. Grate surface, 10.08 square feet. Fire-box surface, 36 square feet. Flue surface, 213 square feet. Cat. No. 180, 001 U.S.N.M.

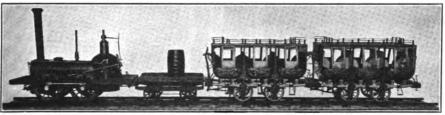


FIG. 35 .- " JOHN BULL " AND TRAIN, 1831.

#### Model of Locomotive "John Bull" and Train. Made in the Museum.

This model represents the locomotive and train as it originally appeared on the date of the initial trip, November 12, 1831. By comparing the locomotive model with the actual engine as it now stands, the outstanding feature to be observed is the absence in the former of the pilot or "cowcatcher." The necessity for a pilot to remove obstructions off the track caused Isaac Dripps, master mechanic of the railroad, to design and add this forecarriage, which not only performed its specified duty but also carried some weight off the front driving wheels and performed, in a way, the functions of the swiveling truck.

Again, it will be observed that in the model the driving wheels are connected by rods (one on each side), while these are absent in the full-size machine. These rods were never used, owing to the sharp curves on the road.

The passenger coaches used were simply stage coaches, common at that time, equipped with flanged wheels. Cat. No. 233,510 U.S.N.M.

Copy of the Original Drawing of the "DeWitt Clinton," the Third Locomotive Engine Built for Actual Service on a Railroad in the United States. Made for John B. Jervis for the Hudson and Mohawk, a Railroad Between Albany and Schenectady, New York, in 1831, by the West Point Foundry Association.

The "DeWitt Clinton" had two cylinders, 5½ inches in diameter and 16 inches stroke; four wheels, all drivers, 4½ feet in diameter,

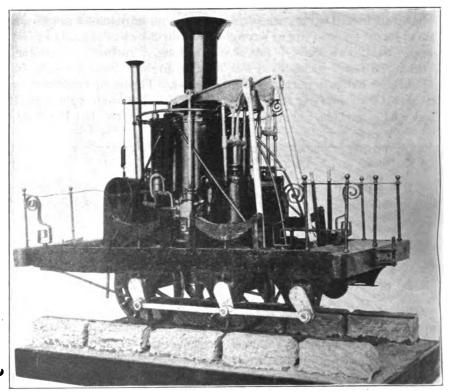


FIG. 36.-PHINEAS DAVIS "GRASSHOPPER" LOCOMOTIVE, 1831.

with all the spokes turned and finished. The spokes were wrought iron, hubs cast iron, and the wheels tired with wrought iron, with inside crank and outside connecting rods to connect all four wheels; a tubular boiler, with drop furnace, two fire doors, one above the other; copper tubes  $2\frac{1}{2}$  inches in diameter and about 6 feet long; cylinders on an incline, and the pumps worked vertically by bell crank. This engine weighed about  $3\frac{1}{2}$  tons without water, and would run 30 miles an hour with three or five cars on a level burning anthracite coal. It was the first engine to run in New York State on a railroad.

Cat. No. 222,113 U.S.N.M.

## Model of the "Grasshopper" Locomotive, 1831. Made in the Museum.

The "Grasshopper" locomotive is so named from its peculiar motion. It was introduced by the Baltimore and Ohio Railroad in 1831, and remained in use on its line for many years.

The "Grasshopper" locomotive, more particularly called the "Atlantic" type, and which became for a time the standard form of engine on the Baltimore and Ohio Railroad, was designed by Phineas Davis, aided by Ross Winans, then assistant engineer of machinery of the Baltimore and Ohio Railroad. The "Atlantic"

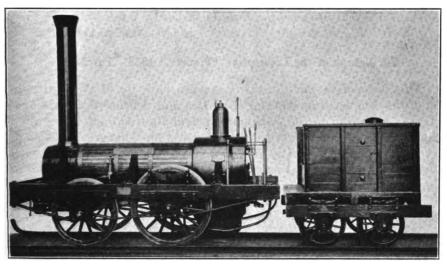


FIG. 37.-MATTHIAS BALDWIN "OLD IBONSIDES" LOCOMOTIVE, 1822.

had a vertical boiler with a fan driven by the exhaust steam for stimulating the fire.

There were two vertical cylinders 10 inches by 12 inches, whose power was transmitted to the supplementary driving shaft by means of a spur and pinion, which was geared up to make the wheels revolve twice for every turn of the crank. In this way wheels 3 feet in diameter were made equivalent to driving wheels 6 feet in diameter. About twenty engines of the "Atlantic" type were built and they worked very successfully in developing railroad traffic, going out of favor only when engines with a longer wheel base became necessary.

Cat. No. 233,511 U.S.N.M.

# Model of the Locomotive "Old Ironsides" and Tender, 1832. Gift of the Baldwin Locomotive Works.

This locomotive was the first built by Matthias Baldwin, the founder of the Baldwin Locomotive Works, in Philadelphia, and 52103—22—-6

hauled the first passenger train in the State of Pennsylvania. The trial trip was made on the Norristown Railroad, November 23, 1832, traveling 6 miles at a speed of 28 miles an hour. After several successful trials "Old Ironsides" with improvements attained a speed of 30 miles an hour with the usual train attached.

The locomotive is a four-wheeled engine with the driving wheels in front of the fire box and the carrying wheels close behind the smoke box. In working order it weighed about 12,000 pounds. The cylinders were 9½ by 18 inches, the driving wheels were 54 inches, and the front wheels 45 inches. The boiler was 30 inches in diameter and contained seventy-two copper flues 1½ inches by 7 feet.

Cat. No. 180,114 U.S.N.M.

### Photograph of the Locomotive "Pioneer," 1836. Purchased.

This locomotive was the thirty-seventh built by M. W. Baldwin and was completed in 1836 for the Utica and Schenectady Railroad. It was later sold to the Michigan Central Railroad and was called the "Alert." While owned by this road a few changes were made on the engine. Originally it had a single fixed eccentric for each cylinder, with two arms extending backward having drop hooks to engage with a pin on a rocker arm which actuated the valve rod. That motion was removed and double eccentrics with V-hook put in its place.

When the Chicago and North Western Railway began to lay its tracks in 1848, they purchased the "Alert" and renamed it the "Pioneer."

The "Pioneer" is the same type as Baldwin's second engine, the "E. L. Miller," but is larger and has 2 inches longer stroke and the improved valve motion just mentioned.

Cat. No. 180,046 U.S.N.M.

# Model of the Locomotive "Sandusky," 1837. Made in the Museum.

This is the first locomotive built by Rogers, Ketcham, and Company, Patterson, New Jersey, completed in 1837, and placed in service on the Mad River and Lake Erie Railroad at Sandusky, Ohio, in 1838. Its cylinders were 11 inches in diameter by 16 inches stroke, with one pair of driving wheels 4 feet 6 inches in diameter, which were placed in front of the fire box. The engine had a truck in front with four 30-inch wheels; the cylinders were inside the frames and were connected to the wheel axle. The eccentrics were outside of the frame and the eccentric rods extended back to rocking shafts which were located on the footboard. The smoke pipe was of the bonnet type and had a deflecting cone in its center. The edges of the cone were curled over so as to deflect the sparks downward. The driving

wheels were made of cast-iron with hollow spokes and rim, which at that time was a remarkable novelty. The section of the spokes was of the old form, and the rim was of very much the same shape as that in use at the present time. Another important improvement adopted in the construction of this locomotive was counterbalancing the weight of cranks, connecting rods, and piston. This counterbalancing was effected by casting the rim of the wheel opposite the crank in solid metal, while the other part of the wheel was made hollow. The importance of counterbalancing was not recognized until several years after it had been introduced by Rogers, Ketcham, and Company, and when attention was drawn to it many doubted the necessity of balancing anything more than the crank.

Cat. No. 180,245 U.S.N.M.

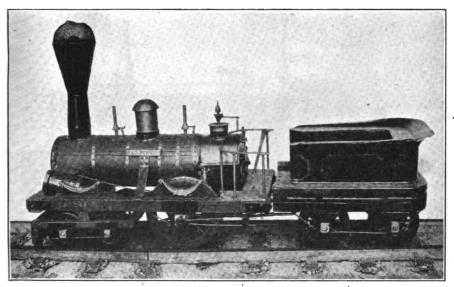


FIG. 38.—ROGERS, KETCHAM & CO. " SANDUSKY " LOCOMOTIVE, 1837.

Model of Locomotive Invented by Asa Whitney, U. S. Patent No. 1653, June 27, 1840. Transferred from the United States Patent Office.

To secure greater traction, this locomotive was designed to operate all wheels as drivers. The boiler, cylinders, etc., are secured to a framework supported on two four-wheel trucks. The forward truck is free to revolve about a center pin through the intervention of conical friction rollers traveling through circular arcs, and the rear truck likewise is equipped with rollers that it may conform to the curvatures and undulations of the track.

The power of the engine is transmitted to the wheels through two bell cranks and other connecting rods and cranks above and on each side of the boiler to a main central shaft beneath the boiler on which is a large spur wheel. This cog engages two cogs on either side of it secured to the axles of the middle wheels of the trucks, and through cranks on the extremities of these axles and connecting rods the power is communicated to the outside wheel axles. Thus all eight wheels are driving wheels.

Cat. No. 251,271 U.S.N.M.

Model of Locomotive Invented by M. W. Baldwin. U. S. Patent No. 2759, August 25, 1842. Transferred from the United States Patent Office.

This locomotive contains features which will permit the wheels and axles to adapt themselves to the curves and undulations of the

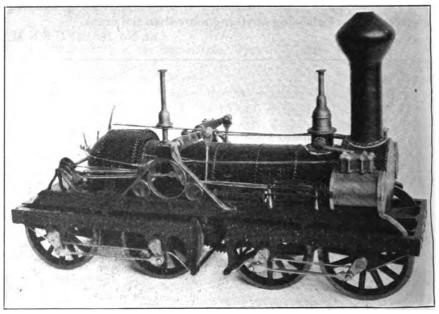


FIG. 89.--ASA WHITNEY LOCOMOTIVE, 1840.

railway bed. An adjustable pin is fixed vertically above the axles and to the frame on each side of the boiler, and extends downward and through a vibrating bar, terminating on the upper surface of the multileaf spring. The fore and aft ends of the spring are connected to the boxes in which the wheel axles revolve. The boxes are made so that they swivel in the plumber blocks which receive them, by boring cylindrical recesses in the blocks. These blocks are secured to the vibrating bar so that the parallelism of the axles is undisturbed.

Cat. No. 251,274 U.S.N.M.

Model of Locomotive Invented by G. H. Nicolls, 1848. U. S. Patent No. 5532. Transferred from the United States Patent Office.

The object of this invention was to maintain the tractive power of a locomotive on ascending grades. The nature of the invention con-

sisted in employing, in addition to the usual large driving wheels, a set of small drivers operated by an additional pair of engines. By this arrangement when the engine reached moderate grades the steam could be shifted from the engines of the large drivers to those of the small drivers. The difference in the diameter of the two sets, it was believed, would enable the pistons that operate the small drivers to work off all the steam generated in the boiler and to exert the required force to draw the train upgrade, although with reduced speed. When ascending grades of greater inclination, both sets of engines and drivers could be brought into play, and thus the locomo-

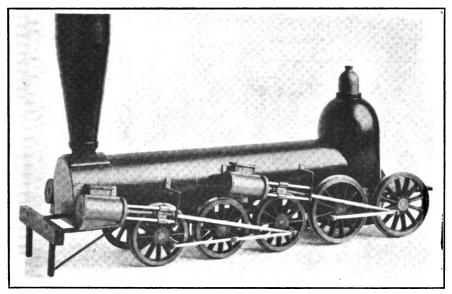


FIG. 40.-NICOLLS GRADE LOCOMOTIVE, 1848,

tive was adapted to all circumstances and rendered effective over the whole length of road without waste of power.

Cat. No. 251,270 U.S.N.M.

# Model of Locomotive Invented by A. Cathcart in 1849. U. S. Patent No. 6818. Transferred from United States Patent Office.

The object of this invention was to enable a locomotive to draw cars up inclined planes without the use of stationary power. It consists in attaching auxiliary cylinders to the locomotive, which act upon a wheel considerably smaller than the ordinary driving wheels. This wheel is toothed and is connected with an intermediate driving wheel, which can be raised or lowered through a circular arc in which the axis of the small wheel is the center. This latter wheel is in turn lowered and gauges in a rack located between the rails.

Cat. No. 251,272 U.S.N.M.

Model of the Running Gear of a Locomotive. Patented in 1851 by Ross Winans and Incorporated in a Locomotive Used on the Baltimore and Ohio Railroad, Called "Carroll of Carrollton."

The early locomotive designers the world over made a common mistake in imagining that the size of driving wheels instead of the size boiler controlled the speed capacity of a locomotive. This idea led Ross Winans to invent and patent a locomotive which was called "Carroll of Carrollton." It had a single pair of driving wheels 7 feet in diameter and four-wheel trucks both front and rear. The deficiency of adhesion noticeable in other engines having larger driving wheels was supposed to be eliminated in this engine, but a trial did not prove this and the engine did not secure any success and never did any regular work.

Cat. No. 251,273 U.S.N.M.

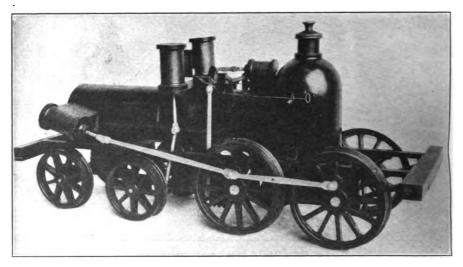


FIG. 41.—CATHCART RACK-RAIL LOCOMOTIVE, 1849.

A Complete Working Model of an "American" Type Locomotive. (Scale  $\frac{1}{2}$  inch equals 1 foot.) Made by George Boshart. Loaned by John S. Clarke, Ardmore, Pa., Vice President of The Autocar Company.

This model is as complete in its interior parts as in its exterior parts and can be operated under its own power with coal for fuel. It represents the passenger type, high-speed simple-cylinder locomotive of the period 1890–1900.

Of the "American" locomotive, Mr. Angus Sinclair, in his book, the "Development of the Locomotive Engine," writes:

For the first forty years of railroad operating, the dominating aim of designers and locomotive builders was to produce a locomotive suitable for all kinds of train service, one that would be fairly efficient and durable enough to make long mileage with small expense for repairs and subject to few failures. Except

on the comparatively few railroads handling minerals and other heavy freight over steep grades, the eight-wheel locomotive, known for excellence as the American locomotive, was regarded as an ideal engine for hauling both passenger and freight trains. In 1870 probably 85 per cent of the locomotives at work on the American continent were of that type. Until the troublesome problem of how to move passenger and freight trains at the least possible expense became dominant in railroad counsels the American locomotive left nothing to be desired as railroad motive power.

The engine was the product of natural evolution, the survival of the fittest, and altogether admirable as a power producing motor. Lest this book be read when the American locomotive becomes classed with the dinosaurs, I may explain that it belonged to what is now denominated as the 4-4-0 class, having a four-wheel truck under the smoke box and two pairs of coupled drivers in front

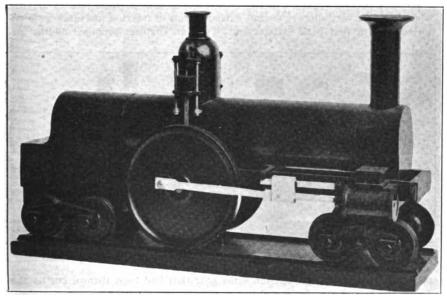


FIG. 42.-WINANS LOCOMOTIVE FOR INCREASED ADMESION, 1861.

and one pair behind the fire box. During the period of this engine's glory a deep fire box passed down between the frames and was compactly bounded by driving-wheel axles and coupling rods. About one-third of the total weight was generally carried on the leading truck.

The perfecting of this form of locomotive represents the most valuable engineering work performed on railroad motive power. The work of Evans, Trevithick, Hedley, Stephenson, Hackworth, Cooper, Baldwin, Dripps, Winans, Harrison, Eddy, Millholland, Rogers, Cooke, and Mason all produced contributions to the perfecting of the American locomotive, and very often the permanent gift of what is regarded as a fertile inventor will be identified as a very small part of that finished machine. We find the first groping toward a locomotive machine was a portable boiler with various accessories attached, such as cylinders and wheels. Then came an arrangement of rectangular beams forming a frame which carried the boiler and provided conveniences for holding the four wheels that carried the whole combination of power generating and transmitting appliances. For the track's sake the carrying burden is dis-

tributed over four pairs of wheels, two of them being in front. The clumsy outside wooden beams that acted as frames are abandoned for iron bars that are not susceptible to changes of temperature and form a light frame which carries the boiler securely and with small superfluous weight to which all operating mechanism is strongly fastened. The engine meets the essential requirements of lightness and strength sufficient to control the increasing power. The elementary locomotive with a single pair of driving wheels is deficient in adhesion and what seems a backward step is taken to make an important move forward. The first engines built before the advent of the swiveling truck were generally carried by two pairs of coupled wheels which gave sufficient adhesion. In the United States one pair of these wheels was abandoned for the leading truck, while in Europe the four-coupled arrangement was adhered to, but a single pair of carrying wheels was introduced in front or in the rear.

When it became apparent in the United States that a single pair of driving wheels made a very slippery engine, various forms of traction increases were resorted to with very little satisfaction. Then an engineer proposed adding an-

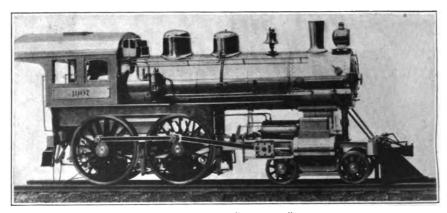


FIG. 43.—COMPLETE WORKING MODEL OF "AMERICAN" TYPE LOCOMOTIVE, 1900.

other pair of driving wheels, the same pair that had been thrown out by the Jervis truck, and won fame and fortune by the invention. The clan Campbell, led by their chief, the Duke of Argyll, have won many victories since, breekless, they first emerged from the wilds of Lorn, but no victory was so abiding and lucrative as that of Henry R. Campbell when he added a pair of driving wheels to the slippery locomotive.

Campbell gave the basis for the American locomotive, but it had to pass through much torturing experiments, due mostly to following of fallacies and fashions, before it emerged from the hands of its friends a highly perfected engine. The Campbell was rudimentary to a degree, but it provided a foundation to succeeding builders. A heavy outside wooden frame carrying a boiler and having pedestals to secure the four-wheel leading truck and the two pairs of driving wheels set very close together formed the visible outlines of the engine. The cylinders were inside under the smoke box and transmitted the power through a cranked axle. It was patented in 1836 and was noted for unyielding, hard-riding characteristics.

For about twenty years, the "American" locomotive was the Rome toward which nearly all locomotive designers traveled. It was a pity that the public demand for increased speed of passenger trains and decreased freight charges should have moved railroad managers to command that more powerful loco-

motives should be provided. That was an order which had to be obeyed, and designers proceeded with the task of putting into form the modern locomotive. The "American" locomotive reached its zenith in 1872. In that year the

Baldwin Locomotive Works built 422 engines, the average weight in working order having been 64,000 pounds. Most of the engines were of the 4-4-0 type.

The favorite 4-4-0 soon reached the limit of its capacity. The grate area limits, the steam producing power of a boiler, and the first attempts to increase the capacity of the American locomotive were directed to increasing the size of the grates. The most popular engines of that type had deep fire boxes passing between the frames, providing a grate about 34 by 72 inches or 17 square feet. The intensity of the popular desire to keep that type of locomotive in use may be judged by the ingenious efforts made to enlarge the grate area. The first movement was increasing the distance between the driving wheels so that the grates could be lengthened. Side rods as long as nine feet came into use, but the increase of grate that resulted proved a short-lived remedy. Then came the practice of sloping the grate and raising the center line of the boiler. By this means the back of the grate was brought sufficiently high to pass over the rear axle, permitting the fire box to extend back an indefinite distance. This permitted the grate to be made as long as it could be fired. Such grates were sometimes made from 9 to 10 feet long, providing an area of about 30 square feet. That kind of fire box was always very unpopular with the enginemen and was wasteful of coal.

In 1891 William Buchanan, of the New York Central Railroad, cooperating with A. J. Pitkin, manager of the Schenectady Locomotives, brought out an abnormally large 4–4–0 locomotive to haul the heavy express trains. It was numbered 870, had cylinders 19 by 24 inches, driving wheels 78 inches diameter, weighed 120,000 pounds, of which 80,000 pounds were upon the drivers. The fire box, set above the frames, provided grate area which was 96 inches long and 40½ inches wide, a total of 27.3 square feet. There were 268 2-inch tubes 12 feet long which, with fire-box area, provided 1,851.5 square feet of heating surface.

That form of engine was largely copied and made heavier, one group having been made with the engine a total weight of 136,000 pounds with 90,000 pounds on the drivers. This was passing the limit, for 22,500 pounds weight pressing the rail beneath each wheel was more than steel rails or steel tires could endure in a fast running locomotive.

The locomotive of which this model was made by direct measurement was still in use in 1907 on the Pennsylvania Railroad.

Cat. No. 307,243 U.S.N.M.

#### PART III.

#### RAILWAY PERMANENT WAY.

Included in the exhibits of transportation are models of railways, models of rails of various designs and sections of over one hundred types of iron and steel rails used since the beginning of the railway era. The more important of these objects are referred to in the following general account of the development of the permanent way, the greater portion of which was prepared a number of years ago by Dr. J. Elfreth Watkins, late curator of the Division of Mechanical Technology.

#### EARLY TRAMBOADS.

By careful calculation, a distinguished London engineer in 1802 found that while it cost 80 cents a ton a mile to transport bulky freight over turnpikes, the cost on horse tramroads of iron was only one-tenth of this amount. George Stephenson, while president of the "British Carring Companies," wrote "that by the introduction of the horse tramroad, the monthly expense of that company for coal carriage alone had been reduced from £1,200 to £300. An edition of "Wood's Treatise of Railroads," published in 1830, calls attention to the economical operation of the coal railroad, 9 miles long, near Mauch Chunk, Pennsylvania, then operated by horsepower, and

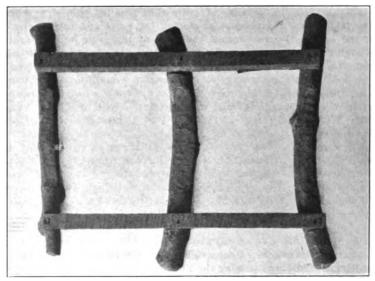


FIG. 44. - MODEL OF WOODEN RAILWAY AT NEWCASTLE, ENGLAND, 1672.

states that by this method "it has repaid its whole cost since 1827." In 1828 39 miles of the horse railway from Budweis to Lintz, constructed across the mountains which separate the Moldau and the Danube Rivers, was opened to traffic. This road was extended 41 miles farther in 1832, and for many years paid a dividend of 5 per cent upon a capitalization of \$10,000 a mile, which was subsequently increased to a length of 130 miles in 1839.

The demand for a new fuel to replace wood was the necessity that became more and more urgent as the forests disappeared to satisfy the demands of a dense population. This condition of affairs directed thought toward devising improved methods for transporting pit coal from the collieries of Great Britain to the adjacent navigable streams or near seaports, with the result that railways were laid in the coal mines and from the mines to the adjacent water-

courses. These ways consisted of squared timber rails laid in the ground and held to gauge by cross timbers to which they were fastened by wooden pins.

Roger North in 1672, in his biography of his brother Francis, the Lord Chancellor, describes a wooden railway (see fig. 44) which he had seen at Newcastle during the reign of Charles II, as follows: "The manner of the carriage is by laying rails of timber from the colliery down to the river exactly straight and parallel, and bulky carts are made with rowlets fitting these rails, whereby the carriage is so easy that one horse will draw four or five chaldrons of coal." The Newcastle chaldron weighed 5,936 pounds, so that one horse hauled 8 or 9 tons.

The price of iron was materially reduced as coal became cheap and abundant, and at length it became possible to use it in the construction of rails. The earliest iron used in track construction was cast in plates 3 or 4 feet long, 2 or 3 inches wide, and one-half or three-fourths of an inch thick. These plates were spiked on top of the wooden stringer rail where the wear was the greatest.

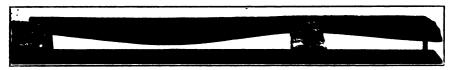


FIG. 45 .-- FISH-BELLY RAIL. PATENTED BY WILLIAM JESSOP, 1789.

As timber was expensive in England at the close of the Eighteenth Century many attempts were made to devise a cast-iron rail that should suit the traffic of the English tramroads. A fair impression can be obtained of the crude ideas that the early English tramway contractors had in regard to rails from the following description of specimens on exhibition:

# Model of Cast-iron Edge Rail, 1789. Patented in England by William Jessop, Mine Engineer, and Laid on a Road in Loughborough.

The rail is fish-bellied and at first was not supported by a chair, the wood or stone block being hewn to fit the end of the rail. Near the ends the rail has a flat projecting base in which there are holes for the bolts which fastened them to the wooden block or sleeper.

Cat. No. 180,205 U.S.N.M.

## Model of Cast Edge Rail, 1797, with Joints Supported by Chairs.

These were the first chairs adopted and were cast the reverse of the ends of the rail, having two bolts through the stem of the rail at each joint. They were laid on the Lawson Main Colliery, New Castle-upon-Tyne, England, by Mr. Barnes, and were at first supported by timber but finally by stone blocks.

Cat. No. 180,207 U.S.N.M.

### Model of Cast Edge Rail, 1802. Invented by Mr. Wyatt.

This rail was used on the railway at the slate quarry on Lord Penrhyn's estate near Bangor, North Wales. The general shape of the cross section of the rail is a hexagon. At each end a dovetail block, 2 inches long, is cast at the bottom. This is slipped into a chair which had previously been attached by a bolt to the wooden or stone support.

Cat. No. 180,205 U.S.N.M.

# Model of Cast-iron Tram Rail, 1803. Used on the Surrey Railway, England.

This rail is said to have been made "with flange higher in the middle and a nib under the tread to add strength." It has a rectangular notch, half square in the ends, the joints being completed by one square-headed iron spike, which is countersunk.

This rail, although an improvement, failed to give general satisfaction, and in a very short time became obsolete.

Cat. No. 180,209 U.S.N.M.

### Model of Cast Rail with Concave Top, 1803.

This rail, patented by Josiah Woodhouse, is fastened to transverse crossties by bolts slipped into slits through the base. It was to be used also by road wagons and to be embedded in common roads.

Cat. No. 180,210 U.S.N.M.

Among the most interesting relics in the collection are two of the cast tram rails, 3 feet long, from the track extending from Pen-Y-Darran Iron Works to Navigation House, Abercynon, Wales. These rails were a portion of the original track upon which Trevithick's first locomotive ran in 1804, and are the gift of J. W. Widdowson, Esq., London and Northwestern Railway, England.

# Model of Cast Tram Rail, Designed to be Laid Without Bolts or Spikes.

Charles Le Cann, of Llannelly, Wales, in 1808 received a premium of twenty guineas from the Society of Arts for the invention of this rail, which was ingenious in construction. Projecting pins, pyramidal in shape, are cast on the bottom of the tram rail at the points where the stone supports come under the rail, the joints being dovetailed into each other; the need of any other form of joint fixture was thus dispensed with. These rails are about 5 inches wide and weigh 42 pounds a yard. Cat. No. 180,211 U.S.N.M.

# Model of Cast Rail, Patented by Losh and George Stephenson of Killingsworth, England, in 1816.

A half lap joint is used through which a horizontal pin is passed transversely to join the rails together, at the same time fastening them to the cast-iron chair. A large portion of the Stockton and Darlington Railroad was laid with this rail in 1825.

Cat. No. 180,213 U.S.N.M.

Early in the eighteenth century inventive genius increased the power of the stationary engine and the efficiency of the steam blast and of the machinery for working and handling iron. The puddling furnace, first used in 1784, was radically improved by Henry Cort about the beginning of the century. He also invented and introduced the rolling mill about the same time, so that it became possible to roll iron rails cheaply. These were at first rolled in lengths of about 12 feet. Models in the collection of the early English rolled rails are:

Bar Rail Laid in Lord Carlisle's Quarries, 1811.

Cat. No. 180,212 U.S.N.M.

### Wrought-iron Edge Rail with Fish-bellied Web.

Rails used by Stephenson in 1829 in laying the Liverpool & Manchester Railway. Chairs were used at joints; rails were 15 feet long and supports 3 feet apart; the weight of rail was 35 pounds a yard.

Cat. No. 180.216 U.S.N.M.

#### THE AMERICAN RAIL AND TRACK.

During 1825-27 a few isolated coal tramroads existed in the mining regions in Pennsylvania and Virginia, and in the stone quarries in Massachusetts. These roads were laid with wooden rails, capped with thin merchant bar iron. About this time the Pennsylvania Society for the Promotion of Internal Improvement sent an engineer abroad to examine English railways. The fully illustrated report made by William Strickland, published during the year 1826, shows that rapid advances in track construction had been made in Great Britain during the preceding decade notwithstanding the fact that comparatively few locomotives were at work and only one railway for general traffic had been opened.

This report, without doubt, contained the most trustworthy information obtainable at that time by American railway projectors. But America presented a very different problem from England to the pioneer railway builders. England was an old country, rich in commerce and foremost in manufactures, of comparatively small

area and very densely settled, having a population of nearly 200 to the square mile of territory, while the population of the whole United States was less than 4 to the square mile. In the seven States, Connecticut, Massachusetts, New York, New Jersey, Pennsylvania, Delaware, and Maryland, where most of the early railways were projected, the average population was a little over 35 to the square mile.

#### THE FIRST BAIL BOLLED WITH A BASE.

According to the minutes of the board of directors of the Camden and Amboy Railroad, September, 1830, Robert L. Stevens, president and chief engineer of that company, who had been ordered to visit England to inspect and report upon railroad matters there, was directed to purchase "all-iron rail," which the management of that company preferred to the wooden rail plated with strap iron. Mr. Stevens sailed a few days later, and it was during this voyage that he designed the first rail ever rolled with a base, whittling several model sections out of wood which he obtained from the ship's carpenter.

He was familiar with the Birkenshaw rail, with which the best English roads were then being laid, but he saw that, as it required an expensive chair to hold it in place, it was not adapted to our country, where metal workers were scarce and iron expensive. He also designed the "hook-headed" spike, which is substantially the railroad spike of to-day, and the "iron tongue," which has been developed into the fish bar, and the rivets which have been replaced by the bolt and nut to complete the joint.

The base of the rail which he first proposed was to be wider where it was to be attached to supports than in the intervening spaces. This was afterwards modified so that the base was made one width-3 inches-throughout. Stevens received no favorable answers to his proposals, but, being acquainted with Guest (afterwards Sir John Guest), then a member of Parliament and proprietor of large iron works in Dowlais, Wales, he prevailed upon him to have the rails rolled at his works. Guest became interested in the scheme, and accompanied Stevens to Wales, where the latter gave his personal supervision to the construction of the rolls. After the rolls were completed Guest hesitated to have them used, through fear of damage to the mill machinery, upon hearing which Stevens deposited a sum of money guaranteeing the expense of repairing the mill in case it was damaged. As a matter of fact, the rolling apparatus did break down several times. "At first," as Stevens, in a letter to his father, described it, "the rails came from rolls twisted and as crooked as snakes," and he was greatly discouraged. last the mill men acquired the art of straightening the rail while it cooled. The first shipment, consisting of 550 bars 18 feet long, 36 pounds to the yard, arrived in Philadelphia on the ship *Charlemagne*, May 16, 1831.

The weight of the rails of the next shipment, several months afterwards, was increased to 42 pounds a yard, the rail being 3½ inches high. Over 30 miles of this rail was immediately laid down. It was fastened to stone blocks with hook-headed spikes; at the joints were iron tongues fastened to the stem of the rail by rivets put on hot. This was the standard rail of the Camden and Amboy Railroad during 1831-40.

From a letter written by Francis B. Stevens to James M. Swank, Esq., special agent of statistics, dated Hoboken, New Jersey, March, 1882, the following extracts are taken:

I have always believed that Robert L. Stevens was the inventor of what is called the T-rail, and also of the method of fastening it by spikes, and I have never known his right to the invention questioned.

Mr. Stevens's invention consisted in adding the broad flange on the bottom, with base sufficient to carry the load, and shaped so that it could be secured to the wood below it by spikes with hooked heads, thus dispensing with the castiron chair, and making the rail and its fastening such as it now is in common use.

In the year 1836 and frequently afterward he spoke to me about his invention of this rail. The Camden and Amboy laid with this rail was opened October 9, 1832, two years after the opening of the Manchester and Liverpool Railroad. Of this I was a witness. This rail, long known as the old Camden and Amboy rail, differed but little either in shape or proportions from the T-rail now in common use but weighed only 36 pounds to the yard. For the next six or eight years after the opening of the Camden and Amboy Railroad it was little used here or abroad, nearly all the roads built in the United States using the flat iron bar, about  $2\frac{1}{2}$  or 3/4 inches, nailed to wooden rails; the English continuing to use the chair and wedges.

My uncle always regretted that he had not patented his invention. He mentioned to me upward of forty years ago that when advised by his friend, Mr. F. B. Ogden, the American consul at Liverpool, who was familiar with the circumstances of his invention, to patent it, he found that it was too late, and that his invention had become public property.

Shortly after the first laying of the Stevens rails on the Camden and Amboy Railroad, the rivets at the joints were discarded and the bolt with the screw thread and nut, similar to that now used, was adopted as the standard.

The Stevens rail did not come into general use for several years, the next road to adopt it being the Boston and Providence, about 1840. On the Boston and Lowell Railroad in Massachusetts the fish-bellied rail was laid in chairs on stone blocks. As late as 1847 the Hudson River Road used the Stevens rail supported by chairs, but these were soon afterwards discarded.

#### CAST-IBON BAILS MADE IN AMERICA.

In Johnson's "Notes on the Use of Anthracite" are described to of cast-iron rails made during 1841 at Lyman's foundry, near Pot ville, Pennsylvania. These rails were designed for colliery railwa They were only 6 feet long. For three or four inches at each end rail had a section similar to the Stevens rail; for the remaining and a half feet the rail was somewhat similar to the English theaded rail.

Previous to the year 1842, when Congress passed the celebr high-tariff law, all imported iron rails were admitted to the could almost free of duty. The tariff on manufactured iron agreed by that Congress increased the cost of English rails so much the railways were forced to seriously advocate the erection of A can rolling mills for the special purpose of making rails.

The first rail mill erected in this country was located at 3 Savage, Allegany County, Maryland. The first rail was roll the summer of 1844. In honor of that event the Franklin In of Philadelphia awarded a medal to the proprietors in October

The rail was of the  $\Omega$  form, similar to the Evans (British) I and the first few hundred tons manufactured were laid on the more and Ohio Railroad between Mount Savage and Cumba A section of this rail, which weighs 42 pounds to the yar presented to the museum by the late Colonel James Randoll many years consulting engineer of the Baltimore and Ohio R. Company.

The Stevens rail had come into general use in America before although several railway companies which had imported from England continued their use on their tracks until the were worn out. For this reason the T-rail without base was on the Boston and Worcester Railroad in 1850, and on the stead branch of the Long Island Railroad as late as 1855. American road, however, without exception replaced the T-strap-rail by rail of the Stevens pattern as rapidly as their function permitted, continuing to import all rails from 1 until 1845.

In the "History of Iron of all Ages," Swank writes (p. 3 "The Montour Rolling Mill at Danville, Pennsylvania, w in 1845 expressly to roll rails, and here were rolled in Oc that year the first T-rails made in the United States." Amo early rail mills were the following, with the date when the to roll rails: Boston Iron Works, May 6, 1846; Trenton Iron Cooper and Hewitt, proprietors, June, 1846; New Engla Company, Providence, Rhode Island, September 1, 1846; Iron Company, Phoenixville, Pennsylvania, November, 184

During the year 1848 a very interesting experiment was tried by the Camden and Amboy Railroad. Arrangements were made with Cooper and Hewitt at the Trenton Iron Works to roll a 92-pound rail, 7 inches high, with a base 4\frac{1}{2} inches wide; 15 miles of the Camden and Amboy road were laid with this rail during the following year. The engineer of that company believed that he had at last solved the problem of track construction, inasmuch as this rail gave an admirable opportunity for a strong joint. By experience it was found that this rail was too rigid and produced so much concussion by the train that the ends soon hammered out, and where the ballasting was imperfect great damage was caused to the rolling stock; consequently, the rail was soon after taken up. Much of this old rail found its way to the cities, where it was bought by architects and contractors for building purposes. A section is in the collection. It was laid between Bordentown and Burlington in 1849.

#### PEAR-SHAPED RAILS.

The early American T-rails were made of inferior iron, and this was one of the causes that led to the adoption of the section with a pear-shaped head, with which many roads were laid during the next fifteen or twenty years.

Sections of four of the pear-shaped rails described in the report of the Railroad Commission of the State of New York for 1845 are in the collection. They are:

New York and Eric Railroad. Fifty-six Pounds to the Yard. In Use in 1855.

Cat. No. 180,225 U.S.N.M.

New York Central Railroad. Fifty-six Pounds to the Yard. In Use in 1855.

Cat. No. 180,226 U.S.N.M.

Buffalo, Corning and New York Railroad. Sixty-two Pounds to the Yard.

In Use in 1855.

Cat. No. 180,218 U.S.N.M.

Saratoga and Schenectady Railroad. Sixty-five Pounds to the Yard. In Use in 1855.

Cat. No. 180,217 U.S.N.M.

The obtuse angle between the lower side of the head and the stem of the rail made it difficult to apply a splice bar of any kind to advantage, and this fact led to the introduction of the ring joint (one iron ring passing through two slots, one in each stem of adjacent rails and passing around under the base of the rail and held in posi-

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tion by a wedge driven between the ring and the rail stem). Chairs and other joint fixtures attached entirely to the base of the rail were also experimented with, but generally without satisfaction, judging from the fact that none survived.

The difficulty in making good joints with the pear-headed rail was overcome by some of the engineers by planing away a portion of the head of the rail for a foot or 18 inches from each end. On the Pennsylvania Railroad and on the Belvidere-Delaware Railroad the rails in some cases were planed with special reference to the use of a splice bar, almost square at the rail head and base, as early as 1857.

In 1853 an interesting experiment was tried on the Boston and Lowell Railroad. After running for some time on the head (pear-shaped) of the rail it was inverted. The effect of three years' running on the base was to round over the outer edges.

#### COMPOUND BAILS.

The difficulty in obtaining satisfactory joint fixtures on the American pear-shaped section led to the introduction of the compound rail. One of wood and iron was designed by Benjamin H. Latrobe in 1841 for the Baltimore and Ohio Railroad. The Z iron was 5 inches high and weighed 45 pounds to the yard. The track consisted of longitudinal undersills, which supported the crossties, 3½ by 6 inches and 7 feet long. The wooden portion of rail was made to fit closely against the stem and under the head of the Z iron, to which it was joined by §-inch bolts with screw nuts. The iron and wood stringer was laid to "break joints," so that no splice bars except a base plate was needed at the joints.

A Section of an Ingeniously Devised All-Iron Compound Rail on the Baltimore and Ohio Railroad in 1848 is in the Collection.

Cat. No. 180,344 U.S.N.M.

Several of the railway companies in New York laid a large mileage of compound rails of various patterns. Four sections of compound rails in the collection which were in use in New York in 1855 are:

> New York Central Railroad. Sixty Pounds to the Yard. Cat. No. 180,236 U.S.N.M.

New York Central Railroad. Seventy-five Pounds to the Yard.

Cat. No. 180,229 U.S.N.M.

Troy Union Railroad. Sixty-five Pounds to the Yard.

Cat. No. 180.235 U.S.N.M.

Troy Union Railroad. Sixty-five Pounds to the Yard.

Cat. No. 180,234 U.S.N.M.

When the track composed of this type of compound rails was new, it is described as being the finest track of the period. No satisfactory nut lock was in use at that time, however, and as the screw threads or rivets wore and traffic became heavier, the different parts of the rails could only be kept together by constant attention, in screwing up the nuts or putting in new rivets. As the rails laid were of iron, the wear of the inner surface was considerable, so that in a little while the track was badly damaged and the old solid rail was substituted.

#### STEEL BAILS.

The first steel rails in Europe are said to have been rolled at the Ebbw Vale Works in Wales, about 1855. The steel was produced by the Uchaturis process. Zerah Colburn states that "the quality of the steel is said to be equal to that used for razors." The difficulty in obtaining good iron on this side of the water led the more prosperous American companies to continue to import steel and iron rails from abroad for some years.

In Swank's "History of Iron in all Ages" it is written that "the first steel rails ever made in this country were rolled at the North Chicago Rolling Mills in May, 1865." These were experimental rails, only a few being rolled in the presence of a committee of the American Iron and Steel Association.

The first steel rails ever rolled in the United States upon order were rolled by the Cambria Iron Company at Johnstown, Pennsylvania, in August, 1867. In no one year during the next five years were more than 40,000 tons of Bessemer steel rails manufactured in the United States.

During 1870–1873 attempts were made by several rail manufacturers to roll rails that should have a steel head and iron web and flange—"steel top rail", as it was called. A considerable quantity of this rail was rolled by the Trenton Iron Company. While this experiment was reasonably successful, the lessened cost of making steel soon afterwards made it practicable to make the whole rail of steel.

The production of steel rails, which aggregated 90,000 tons in 1872, increased from year to year, so that in 1882, ten years later, the output reached nearly 1,500,000 tons, the price falling from \$140 to \$35, and to-day practically the whole permanent way of American railways, amounting to about 404,000 miles of track, is laid with steel rails.

#### PART IV.

#### EARLY HISTORY OF LAND TRANSPORTATION.

The transportation industry had its origin among human burden bearers in every portion of the inhabited globe, and primitive methods are still in vogue in many countries. When man secured control of the animal kingdom beasts of burden were trained to bear loads consisting of indivisible or aggregate units too heavy to be borne by human beings, the larger and more powerful beasts being trained to carry one or more persons at a time.

When it became necessary to move loads too heavy for men or beasts, new methods were adopted, animals being bred and trained for draught. Great weights were transported by animals, which, singly, in pairs, or in greater numbers, were taught by acting in unison to exert great tractive force.

Under these conditions it became necessary to devise vehicles of different kinds to be used for various purposes. The sled, made in many forms, especially in the regions where ice and snow are found, proved of great value. The movement of the "rolling load," composed sometimes of stone columns for buildings, and oftener of lesser weights in the marketing of the products of the forest and the field, required greater ingenuity. The roller under the load, before the invention of derricks, was the method employed in moving the largest stones ever employed by man. As skill and dexterity in the use of tools increased vehicles with wheels were devised and became an important factor in the development of civilization.

The ability to construct vehicles with wheels has been developed at different epochs and in different quarters of the globe. It is generally believed that the roller is the link which connects the use of the ancient sledge with the invention of the primitive solio wheel.

The wheelwrights of every nation have devoted earnest attention to the proper combination of wood, leather, bronze, and iron in the construction of vehicles with wheels and axles, suitable at first for the slow movement of heavy loads and later for rapid movement on common roads and turnpikes.

The perfecting of the wheel has led to the construction of thousands of types differing in the shape of the hubs, spokes, fellies, and tires and in the methods of fitting them together. Vehicles with heavy wheels, composed wholly of wood or of wooden parts held together with rawhide and elastic wood, having hubs lined with iron and tires of the same material, made to run upon axles of steel, now in common use, were not made at the beginning of the nineteenth century.

As wealth increased advantages to be gained from good roads were better appreciated, so that light and strong wheels composed entirely of steel were designed, which, combined with other products of the metal worker's art, have led to the construction of the highest type of wheel. To this mechanism was later added a tire of india rubber, the combination resulting in the construction of the bicycle, which embodies the results of the labors of the most skilled mechanics and which during the decade 1890–1899 was introduced into every civilized country of the globe.

Finally the continued improvement in roads and in the internalcombustion engine and the introduction of the pneumatic tire have resulted in the construction and rapid development of the automobile, which to-day represents the highest form of wheeled vehicle whose economic value can best be expressed in the fact that for every eleven persons in the United States there is one automobile in use.

## Model of Indian Elephant with Howdah. (Scale 1:6.) Made in the Museum.

The small-eared Asiatic elephant has been domesticated for centuries in India, Burmah, and Siam. African elephants, distinguished by their large ears, were used for transportation in ancient times, but since the days of Hannibal all attempts to domesticate them have failed. The model shows the method of transporting men and merchandise in war or for commerce in Southern Asia.

Cat. No. 181,275 U.S.N.M.

### Model of Llama with Panniers. (Scale 1:6.) Made in the Museum.

The llama is a small beast of burden noted for being sure-footed under a heavy load. General Bolivar (1783–1830) estimated that early in the nineteenth century as many as 300,000 llamas were used for transportation in the mining districts of Potosi alone. Since that time the horse and mule have come into more general use.

Cat. No. 181,310 U.S.N.M.

## Model of Horse for Burden and Traction. (Scale 1:6.) Made in the Museum.

The horse was domesticated and used as a beast of burden before the dawn of history. Since the era of improvement in roads and in the construction of vehicles with wheels, the number of horses used for traction has greatly increased in both hemispheres. The domestication of the horse, now found in nearly every part of the world inhabited by man, and the adaptation of that animal to various methods of transportation, has exercised a very important influence upon the advancement of civilization.

Cat. No. 181,332 U.S.N.M.

#### Model of Dromedary with Burden. (Scale 1:6.) Made in the Museum.

The camel has been used from the earliest Biblical times as a beast of burden; the dromedary, with a single hump, in Western Asia, Egypt, and Northern Africa; the bactrian, with two humps and long, thick hair, in the cold districts of Asiatic Russia. Camels are also used for traction in many farming communities of the East and by them merchandise is transported in many eastern countries. The camel is called "the ship of the desert."

Cat. No. 181,274 U.S.N.M.

#### Sedan Chair. Gift of Turkish Centennial Commission, 1876.

The Sedan chair, which receives its name from Sedan, France, where it was first made, was a very popular and widely used mode of transportation during the eighteenth century. They were both privately owned and hired, as is the modern taxicab.

The chair consists of an inclosed seat provided with a glazed door at the front and a window at each side. It was carried by two men by means of horizontal poles which slipped through metal sockets at each side. The outside frame of the chair is covered with leather decorated with paint while the inside is upholstered in brocaded cloth. The inside dimensions of the chair are 26 inches wide, 30 inches deep, and 4 feet 6 inches high.

Cat. No. 181.182 U.S.N.M.

#### Sedan Chair. Gift of the First Japanese Trading Company, 1888.

This chair formerly belonged to Tokugawa Iyehito, the eleventh Taikun of Japan, who presented it to his daughter as a wedding gift when she was betrothed to Prince Hosokawa, a Duke of Higo.

The chair resembles a miniature one-room house whose four corners, however, are not vertical but inclined so that its ceiling area is less than that of the floor. It is covered by a double roof, the lower being a low arch, while the upper is a ridge roof of high pitch.

There are two sliding doors, one on each side of the chair, which are screened but permit perfect visibility of the occupant. There is also a screened opening in the front of the chair.

It is constructed of ebony, heavily inlaid and trimmed with gold. The interior is upholstered and decorated throughout in colors. It is carried by a pole supported on the shoulders of two men, the pole passing between the two roofs and extending 5 feet beyond the front and rear. The inside dimensions are 30 inches wide, 4 feet deep, and 30 inches high.

Cat. No. 180,070 U.S.N.M.

#### Model of American Indian Travois. (Scale 1:6.) Made in the Museum.

Long saplings are attached at the butt ends to a strap across the horse's breast and by thongs to the girth; the thin ends drag upon the ground often 6 or 8 feet. Forage, fuel, game, and oftentimes persons were conveyed from place to place by traveaux.

Gat. No. 181,254 U.S.N.M.

#### Model of Primitive Sledge. (Scale about 1:6.) Made in the Museum.

The American colonists fashioned the sledge from the forked limb of a tree. Aborigines and early settlers also used the forked limb, a convenient shape provided by nature, for tongues and thills of sledges and carts.

Cat. No. 181,252 U.S.N.M.

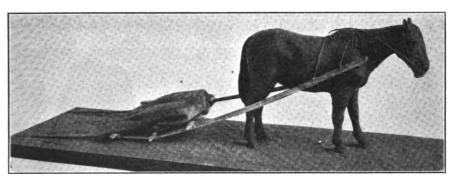


FIG. 46. -- AMERICAN INDIAN TRAVOIS.

#### Model of Sledge of Split Logs. (Scale 1:6.) Made in the Museum.

This form of sledge was used by the American colonists of the seventeenth century for carrying loads too heavy for the backs of man or beast. It is a crude sledge made with primitive tools and is known as the "buck" in eastern Pennsylvania.

Cat. No. 181,253 U.S.N.M.

### Model of Colonial Sleigh, 1783. (Scale 1:6.) Made in the Museum.

This form of sleigh was used by the American colonists in the eighteenth century. Owing to the bad roads, four horses were frequently attached to the sleigh, especially when long journeys were attempted. It has strongly built solid runners with body braced by iron rods.

Cat. No. 181,256 U.S.N.M.

# Model of Egyptian Sledge and Rollers. Made in the Museum. (Modeled After Mural Painting, Temple of Luxor, Thebes.)

The sledge was used in ancient Egypt on funeral occasions and for many other purposes.

Cat. No. 181,255 U.S.N.M.

## Model of Chinese Passenger Wheelbarrow. (Scale 1:6.) Made in the Museum.

This vehicle, with one wheel, is used throughout China for transporting passengers and baggage from place to place. The wheel of twenty spokes, composed entirely of wood, has a heavy rim.

Cat. No. 181,279 U.S.N.M.

#### Korean Single-wheel Chair.

This vehicle, illustrating the application of the wheel to the carrying chair was long used for conveying persons of high rank from place to place in Korea in the Old Period. Its use is now prohibited. The wheel is 30 inches in diameter, has 32 spokes, a heavy hub, and broad rim shod with an iron tire, the cross section of which is V-shaped. The wheel is situated vertically beneath the chair seat. Cat. No. 209,426 U.S.N.M.

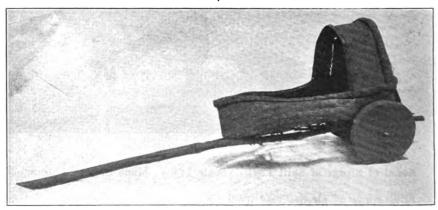


FIG. 47.-BASHKIRS CHILD'S COACH.

## Model of Bashkirs Child's Coach. (Scale about 1:6.) Made in the Museum.

This coach is one of the oldest surviving types of vehicles for human transport and is a child's primitive vehicle from Russia. The wheels, pierced by burning, revolve on a crude axle, to which a tongue consisting of a forked stick is attached by thongs. The body, with arched top, is composed of tree bark sewn together.

Cat. No. 181,280 U.S.N.M.

#### Model of Nantucket Fish Cart. (Scale 1:6.) Made in the Museum.

This vehicle comes from the region where the sandy soil prevents the wheel from being used. A long barrel of small diameter made for the purpose takes the place of a wheel. Its width is about equal to that of the body of the cart and is located to the rear.

Cat. No. 181,261 U.S.N.M.

#### Model of Greek Scytala. (Scale 1:6.) Made in the Museum.

The four wheels are attached to two thick axles which revolve in transverse grooves and cut the sides of the body frame. Aristotle states that the scytala, which has four "pauc" (drum-shaped) wheels, "has many advantages over carts with wheels," arguing that "an axis impedes the progress of wheeled vehicles by pressing on the hub."

Cat. No. 181,268 U.S.N.M.

#### Model of Ancient Egyptian Chariot. (Scale 1:6.) Made in the Museum.

The original chariot of the Ptolemaic Era, complete in every part, made of birch wood, is preserved in the Florentine Museum, Italy. The wheels, of four spokes framed around the hub, are composed wholly of wood; the round rim is in four parts, the joints being scarfed for wrapping with thongs. Cat. No. 181,264 U.S.N.M.

#### Model of an Egyptian Chariot. (Scale 1:6.) Made in the Museum.

The chariot was used in Egypt about 300 B. C. One original wheel, together with the front and side raves, found at Dashour by H. Abbot, is in the Museum of the New York Historical Society. The wheel is 39 inches extreme diameter. The forked brace to which the shafts are attached is also preserved. The construction of the floor and arrangement of the thongs, based upon close measurement, are hypothetical. The wheels have six spokes, with slot near the hub, and felly in six pieces with scarfed joints. The tire of wood, in six parts, also scarfed, is attached to the felly by a lacing of thongs.

Cat. No. 181,265 U.S.N.M.

### Model of Persian Farm Cart. (Scale about 1:6.) Made in the Museum.

The cart, found in Persia in 1870, is used in Khosrovah for general purposes, where wheels of the kind represented last for years. The wheels have fifteen spokes; the felly is in five parts, joined by pins driven into the ends of flat spokes fitted into the rim. The axles and hubs are of wood.

Cat. No. 181,276 U.S.N.M.

## Model of Roman Farm Plaustrum. (Scale about 1:6, after bas relief by Lucius Petus, Rome.) Made in the Museum.

This vehicle was used in ancient Rome in 300 B. C. to transport hay and other agricultural products from the farm to the market. Two wheels of solid wood are each straightened by two pairs of battens set at right angles.

Cat. No. 181,270 U.S.N.M.

#### Model of Burmese Car of State. (Scale 1:6.) Made in the Museum.

This car was used in Burma up to about 1870 by the Phoongyes (priests) upon ceremonial occasions, when it was drawn by a pair of buffaloes. The wheels, without spokes, but composed wholly of wood, are strengthened by cross braces tied by thongs near the rims.

Cat. No. 181,273 U.S.N.M.

#### Model of East Indian Village Cart. (Scale 1:6.) Made in the Museum.

This type of cart has been in general use in Gujerat, India, since 1876, for hauling heavy or bulky loads. The wheels have four heavy

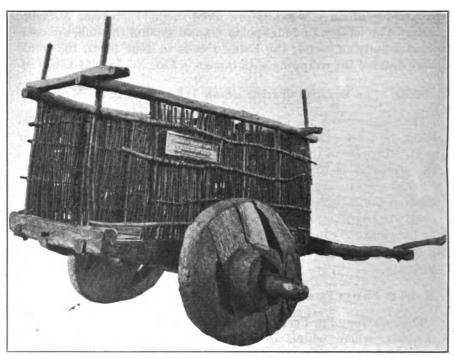


FIG. 48.—SPANISH OX CART, 1850.

fellies and only four spokes, which extend across the wheel and are framed on the outside of the hub. The axles and journals are generally of iron as shown.

Cat. No. 181,281 U.S.N.M.

### Model of Japanese Jinrikisha. (Scale 1:6.) Made in the Museum.

This vehicle, always drawn by men (called "Riksha Boys"), was introduced into Japan by an American missionary about the middle of the ninteenth century, and is in general use throughout that empire. The wheels have sixteen spokes, with metal bearings in hubs. The body is supported on springs attached to an iron axle.

Cat. No. 181.278 U.S.N.M.

#### "Carreta" or Ox Wagon. Presented by Schutter and Hotz.

This vehicle is of Spanish origin and was used extensively in Mexico and New Mexico until about 1880. It is devoid of all metal fittings and is made of cottonwood. The heavy wheels, composed of three pieces of thick timber, are held together by dowels of wood. The outer blocks show the traces of a rim. This type of wheel was introduced by the Spanish and is still to be found in Spain.

Cat. No. 180,132 U.S.N.M.

## Model of Method of Rolling Tar Barrels. (Scale 1:6.) Made in the Museum.

The method of rolling loads by means of two tar barrels rolling on parallel axles in the same frame was in vogue in North Carolina

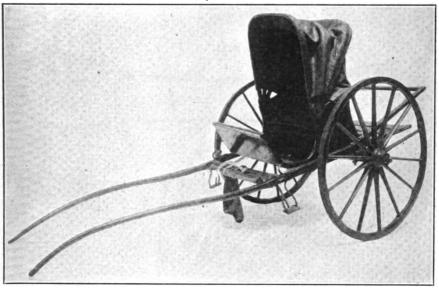


FIG. 49.—COLONIAL CHAISE, 1770.

in 1875 for transporting tar products obtained by "hacking" from the forest to the steamboat or railway. Cat. No. 181,260 U.S.N.M.

### Model of Tobacco-Rolling Hogshead. (Scale 1:6.) Made in the Museum.

The method of transporting tobacco by means of the rolling hogshead was in use throughout Virginia and neighboring States from 1750 to 1861. Oxen, mules, and horses were employed in different localities.

Cat. No. 181,259 U.S.N.M.

#### Model of American Colonial Chaise. (Scale 1:6.) Made in the Museum.

The chaise was used in the American colonies in 1770. It is the "Old One-horse Shay" made famous by Oliver Wendell Holmes. The body was attached to the "running gear" by leather straps adjusted by buckles. The wheels have fourteen spokes, with metal tires. Axletrees, at first wholly of wood, were later strengthened by iron bars and wearing surfaces. The hubs were in emergency lined with thick leather when it was not possible to obtain the cast-iron "box." Cat. No. 181,284 U.S.N.M.



FIG. 50.—CONESTOGA WAGON FOR FREIGHT, 1800.

#### Model of Conestoga Wagon. (Scale 1:8.) Made in the Museum.

This wagon was used for transporting merchandise and often emigrants from the North and East across the Allegheny Mountains to Wheeling and Pittsburgh, on the way toward the South and West. Six and sometimes eight large horses composed the team. The four wheels, strongly built, with fourteen spokes and iron tires, ran upon axles of hickory often shod with iron skeins, the hubs being equipped with iron boxes.

Cat. No. 180,044 U.S.N.M.

#### Model of American Stage Coach. (Scale 1:6.) Made in the Museum.

The stage coach, a vehicle for fast overland travel and mail conveyance, often in connection with steamboat lines, was in general use throughout the United States from the beginning of the nineteenth century until railway systems, extending into new territory, accommodated the travel. Through the agency of competing transportation lines the speed of the American horse for stages of eight or ten miles was materially increased. Four strong wheels, with iron tires and wooden spokes varying in number according to the dictum of local wheelwrights, were attached to strong and light running gears, differing in design and method of attaching springs and bracing.

Cat. No. 180,055 U.S.N.M.

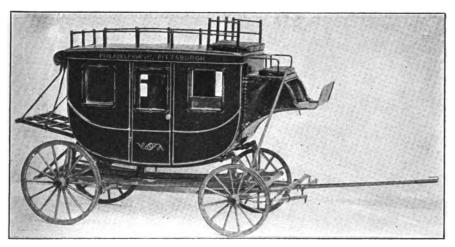


FIG. 51.-OVERLAND STAGE COACH, 1800.

### Model of Red River Cart, 1882. (Scale 1:6.) Made in the Museum.

According to Robinson's "Great Fur Land," published in 1872, "the only tools necessary not only to mend but to construct a [Red River] cart, are an ax, a saw, and an auger; with these the half-breed is independent. Huge trains of these vehicles are used for freighting over the northern plains." The wheels of twelve spokes are very much "dished." Rawhide is used in place of metal in strengthening the joints of the rims and hubs.

Cat. No. 181,309 U.S.N.M.

# Model of An Automobile Truck, 1921. (Scale, One-fourth Actual Size.) Made and Presented by The Autocar Co.

The indispensability of the automobile truck to modern civilization has been demonstrated again and again, and more definitely than ever throughout the period of the World War. The effects of the material breakdown in the railway transportation system during that crisis were considerably allayed by the use of motor trucks moving over long distances, a feat which, prior to that time, had been considered impracticable, so that to-day, following peace-time pursuits, the automobile truck has come to be considered an essential part of the transportation systems of the country.

Among the mechanical features of the truck of which this model is a reproduction, are the following:

The frame on which the body rests is made of pressed steel of channel section and so fitted with cross members and braces as to combine strength and light weight with the desired flexibility. The frame rests on four semi-elliptical springs that are provided with the

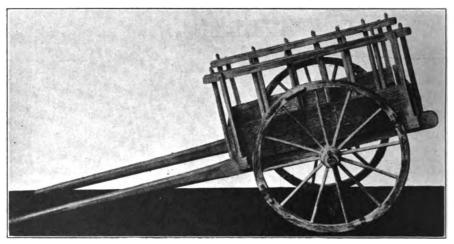


FIG. 52.-RED BIVER CART FOR FREIGHT, 1860.

necessary bushings and special lubricating devices so that they may be readily and easily lubricated. These, in turn, are supported on the front and rear axles, the front axle being of drop-forged steel of I-beam section. The front wheels are mounted on adjustable tapered roller bearings. The rear axle is of the full-floating Autocar double-reduction gear-driven type, the gear reduction being compounded through bevel and spur gears. This reduces the angularity of the propeller shaft, giving straight lines for the transmission of power.

The rear wheels are mounted on adjustable tapered roller bearings carried on an extension of the axle housing. By this means the rotating parts of the rear axle carry no part of the weight, their only function being to transmit the power to the rear wheels.

The gasoline four-cylinder engine is located under the driver's seat and is carried on the main frame by means of a three-point

suspension. The power transmission is of the selective type, there being four forward speeds and one reverse. The transmission-gear housing is suspended from the main frame at three points, the power from the engine delivered to the transmission through a fabric-disk universal joint. Power is delivered to the rear wheels from the transmission through a tubular drive shaft equipped with universal joints at either end.

The general dimensions of the truck are as follows: Length of wheel base, 156 inches; length over all from front of bumper to end of frame, 259 inches; width over all to outside of hub caps, front wheels, 76½ inches; width over all to outside of hub caps, rear wheels, 81½ inches; length of frame, back of cab, 176 inches; length of body, 16 feet; width of body, 6 feet; height of side racks, 40 inches; capacity, 20,000 pounds total—chassis, body, and load; wheel tread,

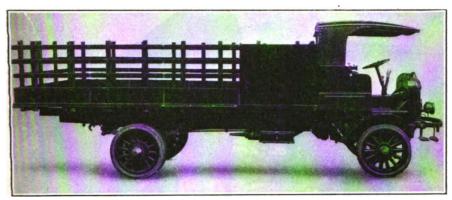


FIG. 53.-AUTOMOBILE TRUCK, 1921.

63 inches on front wheels and 65 inches on rear wheels; tires, 36 inches in diameter.

This type of truck is extensively used in all lines of business which have loads of variable bulk, such as general hauling, building supplies, and wholesalers' wares. Cat. No. 307,255 U.S.N.M.

Working Model of Automobile Truck with Tilting Body, 1921. (Scale one-fourth actual size.) Made and Presented by The Autocar Co.

The general specifications of this truck are almost identical to those of the truck just described except for the differences caused by the use of a shorter wheel base for the present truck. Its particular mechanical feature is the means for tilting the body, which may be pitched at an angle of 40 degrees.

The power is obtained from the transmission gears through a worm drive, the control being a hand lever mounted on the left-hand side of the chassis. A sliding gear, operated by the control lever, meshes with an idler gear and with a driving gear in the trans-

mission housing. These gears are inclosed in a housing placed over the transmission housing. Through this set of gears power is thus transmitted through a driving-gear shaft connected by a universal joint to the power-hoist universal drive shaft. The lifting mechanism, inclosed in a casing, is carried on a steel subframe placed to the rear of the transmission housing. The power-hoist universal drive shaft is connected by a universal joint to a worm shaft on which a worm is keyed. The worm drives a worm gear placed beneath it and mounted on a shaft, on the farther end of which is a pinion. This pinion meshes with an intermediate shaft gear. Mounted on the same shaft as the latter gear is the crank-shaft drive pinion, and power is delivered through it to a large ring gear. This ring gear is

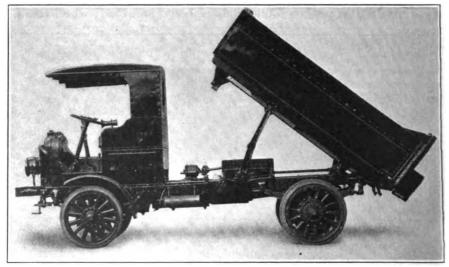


FIG. 54 .- AUTOMOBILE TRUCK WITH TILTING BODY, 1921.

bolted on the ring-gear hub, which is carried on the crank shaft, the ends of which are splined, and the body lifting cranks fit over the ends. The body-lifting cranks and the body-lifting links are connected by a crank pin. The links are hinged to the body angle sills by means of link brackets and link pins. When power is applied through this set of gears, the body-lifting cranks are made to rotate, and when the cranks and links are straightened out fully the body has attained an angle of 40 degrees. Shift gears are also provided in this mechanism, so that a reverse motion is obtained in order that the body may be raised part way up and then, by means of changing the location of control lever, lowered to the frame. Hoisting of the body may be accomplished by rotating the crank arms in either direction. The body-lifting link brackets are fitted with bushings, whose diameter is about  $\frac{1}{16}$  of an inch larger than that of the

body-lifting link pins. This allows the body-lifting links to travel past dead center without any hard impact when the body touches the frame on the downward motion, and also prevents a jarring pull when the body is about to start on the upward motion. The rear end of the body is hinged to the chassis frame by means of two brackets bolted to the angle sills on the body. The body-hinged bracket shaft is carried in these two brackets.

The general dimensions of this truck are: Length of wheel base, 120 inches; length over all from front of bumper to end of frame, 223 inches; width over all to outside of hub caps, front wheels, 76½

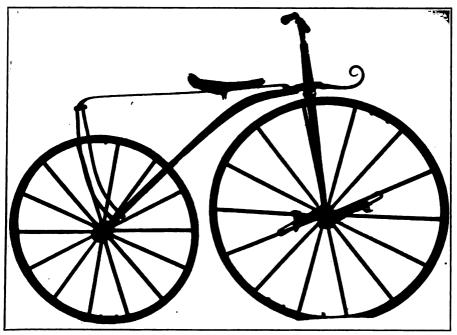


FIG. 55 .- HANLON TYPE VELOCIPEDE, 1866.

inches; width over all to outside of hub caps, rear wheels, 81½ inches; length of frame, back of cab, 140 inches; turning circle, 42 feet; capacity, 20,000 pounds—chassis, body, and load; tires, 36 inches in diameter; wheel tread, 63 inches on front wheels and 65 inches on rear wheels.

Cat. No. 307,256 U.S.N.M.

CYCLES.

Velocipede. Made in Dayton, Ohio, 1866. Purchased 1888.

This machine is of the type developed by the Hanlon Brothers, who were the American contemporaries with Pierre Lallement of France, whose design of velocipede laid the foundation of modern cycling.

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The frame is of wrought iron, the wheels of wood with iron tires, the front wheel being 36 inches in diameter and the rear wheel 30 inches. It is propelled by brass pedals fitted to slotted cranks on the front wheel, the rider sitting on a saddle mounted on a horizontal strap iron spring, supported over the front wheel by the socket head and over the rear wheel by curved iron struts extending vertically from the wheel bearings. The machine is steered by a straight line handle bar at the top of the wheel fork. The slotted crank arms permit leverages from 5½ to 9½ inches. The pedals revolve freely on



FIG. 56.-VELOCIPEDE, 1870.

the crank axle, but are held in the correct position by brass weights on their lower side, which weights are an integral part of the pedal casting.

Cat. No. 180,456 U.S.N.M.

### Velocipede, 1867. Gift of William Sturgis Bigelow, 1907.

This machine is very similar to the preceding one except that the strap iron spring of the "backbone" inclines to the rear. In addition, the machine is equipped with a brake on the rear wheel applied by a cord, which can be tightened by twisting the handle bar; also, foot rests are provided on an extension of the "backbone" beyond the handle bar.

Although the saddle position is adjustable, the rider sat so far behind his work that the power was badly applied and hills or rough roads were difficult to travel on.

Cat. No. 247,884 U.S.N.M.

Velocipede, 1870. Gift of the Goodyear Rubber Company, 1897.

This machine is a further development of the Hanlon design, involving a steel spring and a strap seat suspension and an improved brake on the rear wheel operated by rotating the handle bar, which transmits pressure through a system of rods and springs.

The frame of the machine consists of a front-wheel iron fork pitched back slightly from the vertical, and a diagonal fork extending from the front-wheel socket head to the rear-wheel bearings. A strap saddle is suspended between the socket head and two springs midway of each branch of the diagonal fork. The machine is driven by metal spool pedals fitted to short cranks on the front

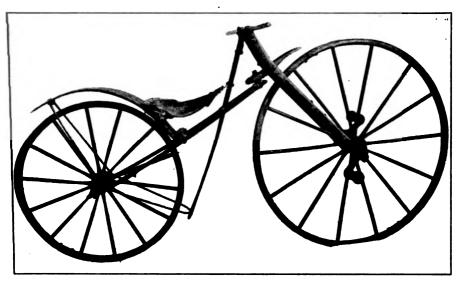


FIG. 57.—BICYCLE, 1879.

wheel. The wheels are of wood with iron tires, the front wheel 38 inches in diameter and the rear 30 inches.

Cat. No. 181,651 U.S.N.M.

Bicycle, 1879. Patent Allowed J. Shire, Detroit, Michigan. Gift of C Howard Buckler, 1907.

The frame of this machine is entirely of wood braced with iron. The front fork pitches backward at an angle of 45 degrees and terminates in a short handle bar. From a pivot back of the front fork and above the wheel a diagonal fork extends to the rear wheel bearings and a wood brace extends from the center of the handle bar downward between the branches of the diagonal fork to a point about three inches above the ground and in front of the rear wheel, which is attached to iron struts from each rear-wheel bearing. A

broad wooden mud guard is fitted over the rear wheel, supported at one end by vertical iron struts extending from the rear wheel, and at the other to the diagonal rear-wheel fork. Secured to this mud guard is the saddle. The machine is driven by wooden spool pedals fitted to short cranks on the front wheel.

Cat. No. 248,087 U.S.N.M.



FIG. 58.-" GRASSHOPPER" BICYCLE, 1880.

### "Grasshopper" Bicycle, 1880. Gift of Thomas M. Wilkins.

This machine consists of a metal frame with a 22-inch wire wheel in front and a 54-inch wire wheel in the rear. It was developed as a result of the tendency of its predecessor, the "Ordinary" (having the small wheel in the rear), to pitch the rider head first upon striking an obstruction in the road. The front wheel is swung in a fork whose branches join above the wheel and continue upward within a metal tube to the handle bar. The rear wheel is secured by a series of solid iron struts between this tube and its axles and to a short strap-iron plate on which the saddle is placed. The machine

is driven by a system of levers and leather clutches on the rear wheel hub, with a spring to recover the pedals at each downward stroke. The wheels are equipped with solid rubber tires and spoon brake on the rear wheel operated from the handle bar.

Cat. No. 248,836 U.S.N.M.

#### Columbia Bicycle, 1885. Gift of E. H. Sithens.

This type of bicycle, sometimes known as the "Ordinary," having the large front wheel and small rear wheel, was very much in favor from 1880–1890. The frame is constructed of steel tubing. The front



FIG. 59.-LADY'S "VICTORIA" BICYCLE, 1887.

wire-spoke wheel is 54 inches in diameter, equipped with solid tires. The pedal cranks are fitted with two holes for adjusting the position of the pedals, and a spoon brake operating on the top of the front wheel is controlled by a lever from the right handle bar.

This particular machine has been ridden over 10,000 miles and was used to some extent in racing events.

Cat. No. 307,216 U.S.N.M.

### "Star" Bicycle, 1881. Gift of Robert Atwater Smith.

This machine was made by the H. B. Smith Machine Company, Smithville, New Jersey. It consists of a small 22-inch wire wheel in front and a large 36-inch wire wheel in the rear, joined by a triangular wrought-iron bar frame. The riding saddle is fitted to a short metal plate fastened at one end to the main frame and at the other to struts

from the rear wheel axle. The machine is driven by treadles of the "grasshopper" type. It is equipped with curved handlebars, spoon brake on the rear wheel, a solid rubber tire on the front wheel, and a pneumatic tire on the rear wheel.

Cat. No. 279,005 N.S.N.M.

Safety Bicycle, 1883. Marked "Psycho, St. John Works, Coventry, England." Gift of J. E. Hosford.

This type of bicycle incorporates all of the advantages of the high-wheeled type with none of the disadvantages. The rear wheel, 36 inches in diameter, is driven by means of a chain and sprocket through a sprocket and pedals fitted in the frame directly beneath the rider. The equipment includes curved handlebar, spade handles, and brake on the front wheel, solid wire wheels, and oil lamp.

Cat. No. 218,118 U.S.N.M.

Safety Bicycle, 1885. Marked "New Rapid. Made in England." Gift of H. K. Griffith, 1899.

This machine consists of a heavy iron frame with a 30-inch wire front wheel and a 32-inch wire rear wheel, both having steel rims and solid rubber tires. It is driven by chain and sprockets, the pedals being placed vertically beneath the saddle.

Cat. No. 201,660 U.S.N.M.

Lady's Bicycle, 1887. Marked "Victoria." Gift of May H. Mead, 1903.

This machine consists of a drop frame with spring-fork attachment to the forward wheel. It is driven by chain and sprockets, steered by a curved handlebar with spade handles. The brake acts on the rear wheel connected by wires and levers on the handlebar. The wire wheels are 28 inches in diameter, equipped with solid rubber tires. The machine was made by the Overman Wheel Company, Boston, Massachusetts.

Cat. No. 214,971 U.S.N.M.

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